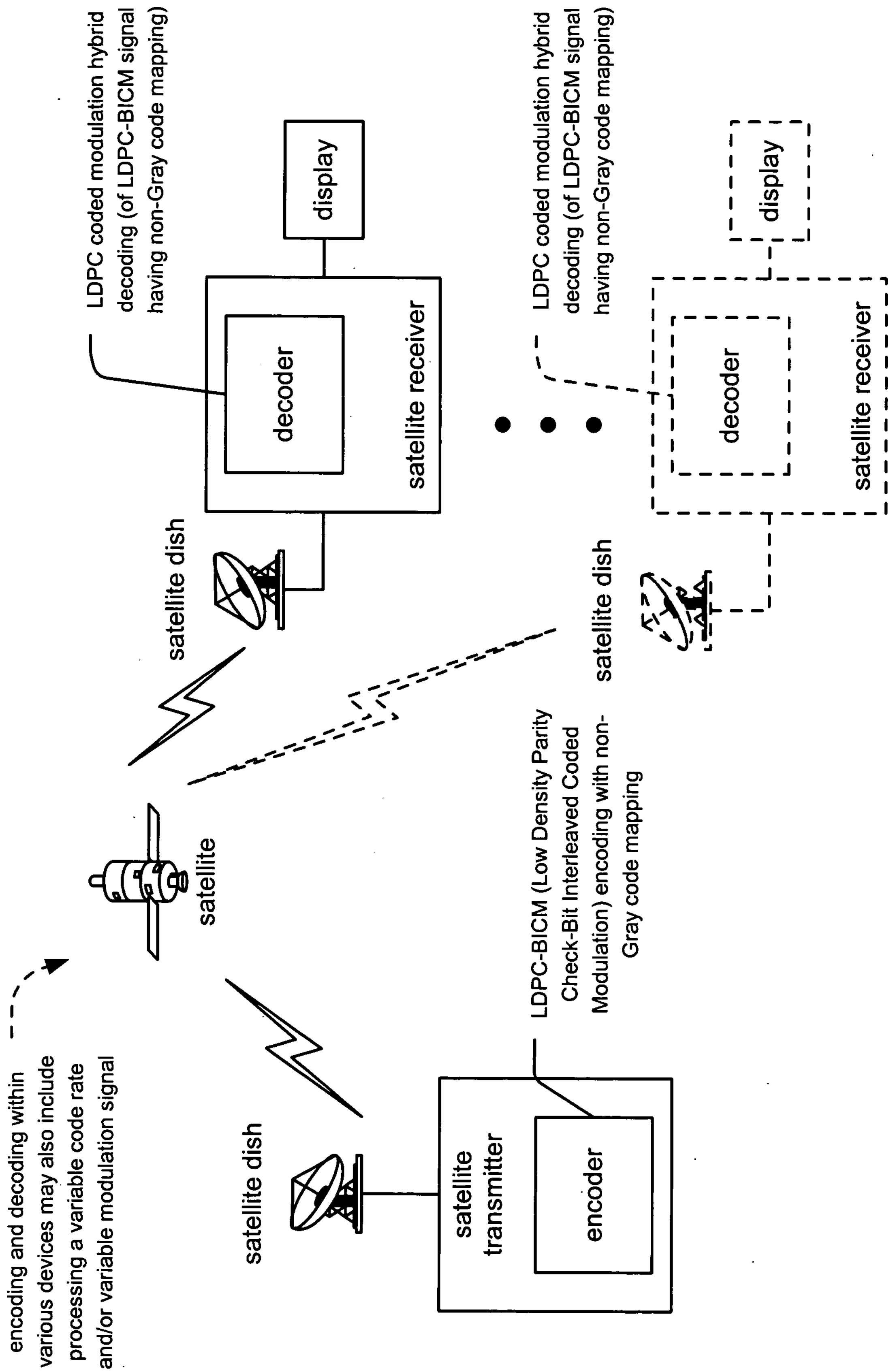
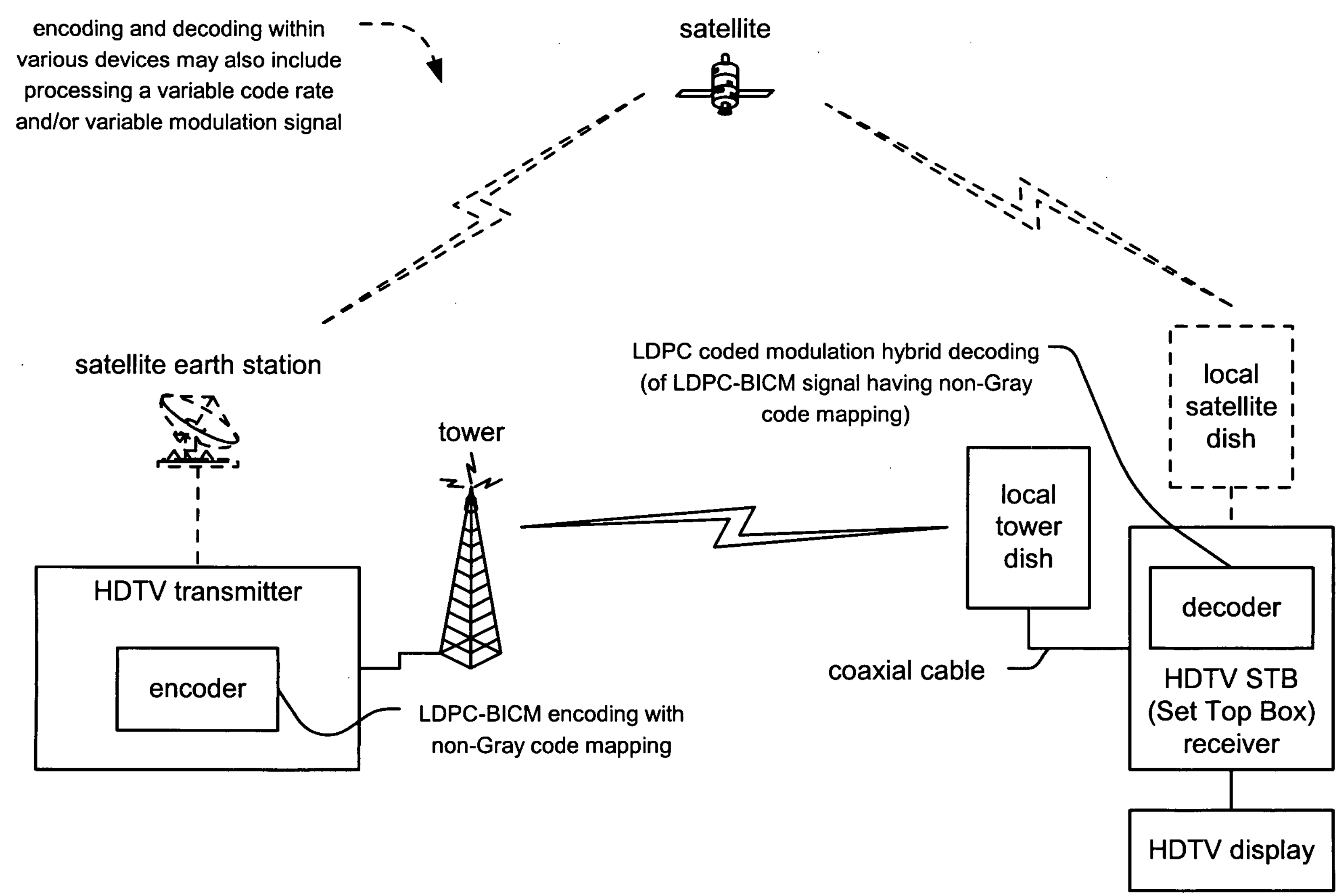


satellite communication system

Fig. 1



HDTV (High Definition Television) communication system

Fig. 2

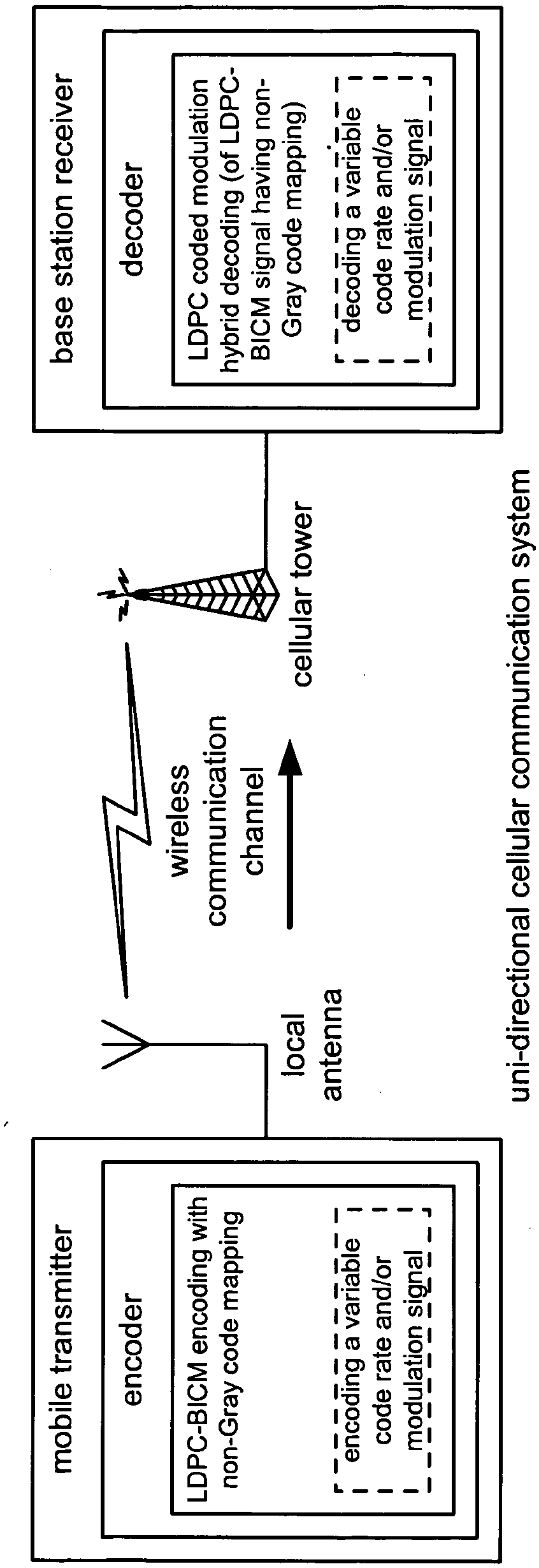

mobile transmitter
encoder
LDPC-BICM encoding with non-Gray code mapping
encoding a variable code rate and/or modulation signal
local antenna
wireless communication channel
cellular tower
base station receiver
decoder
LDPC coded modulation hybrid decoding (of LDPC-BICM signal having non-Gray code mapping)
decoding a variable code rate and/or modulation signal
uni-directional cellular communication system

Fig. 3A

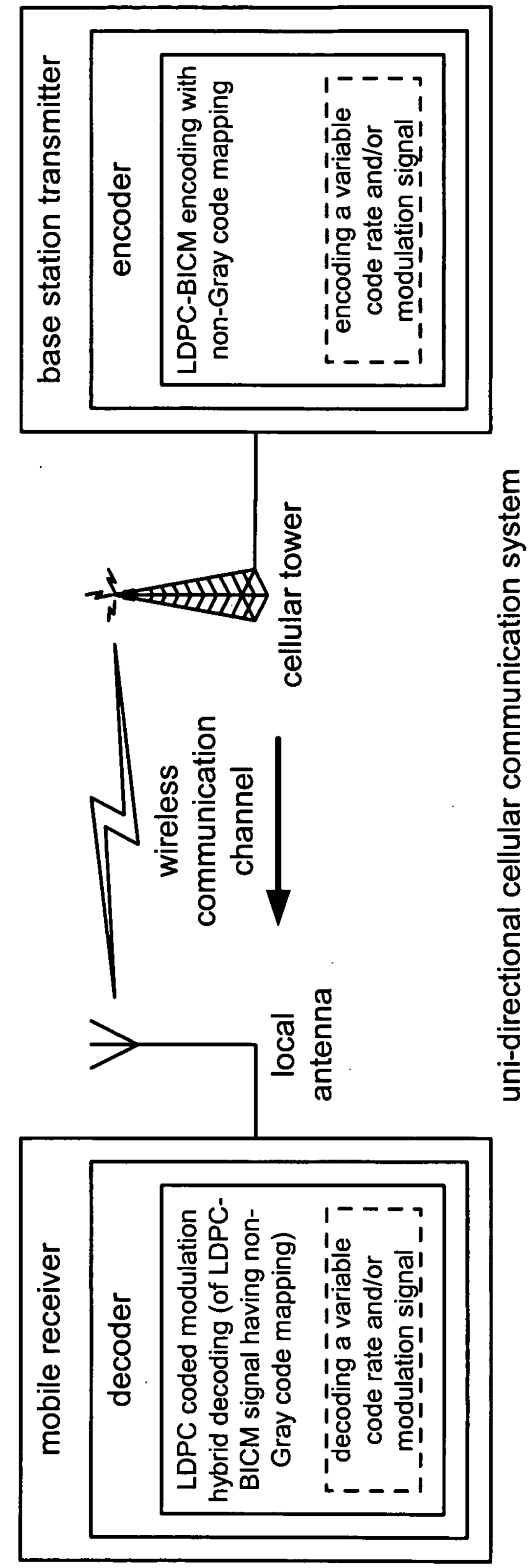

mobile receiver
decoder
LDPC coded modulation hybrid decoding (of LDPC-BICM signal having non-Gray code mapping)
decoding a variable code rate and/or modulation signal
local antenna
wireless communication channel
cellular tower
base station transmitter
encoder
LDPC-BICM encoding with non-Gray code mapping
encoding a variable code rate and/or modulation signal
uni-directional cellular communication system

Fig. 3B

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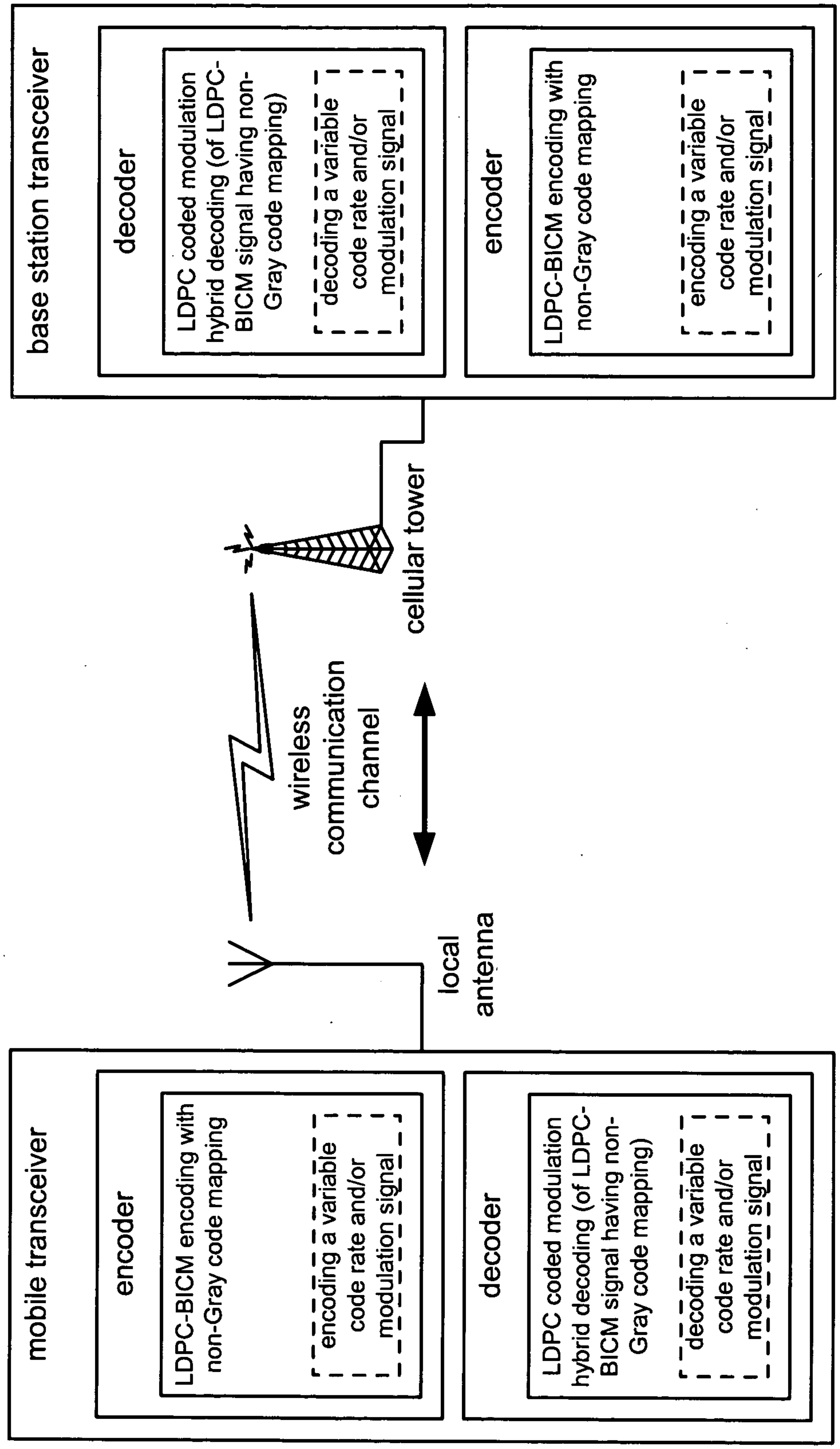
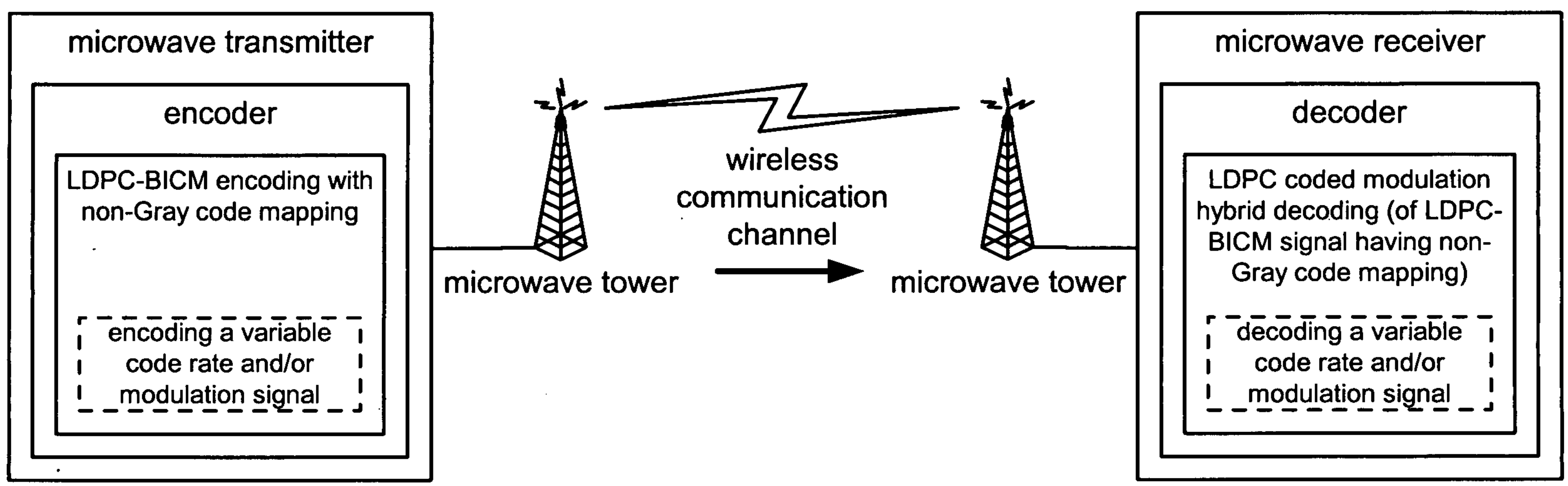


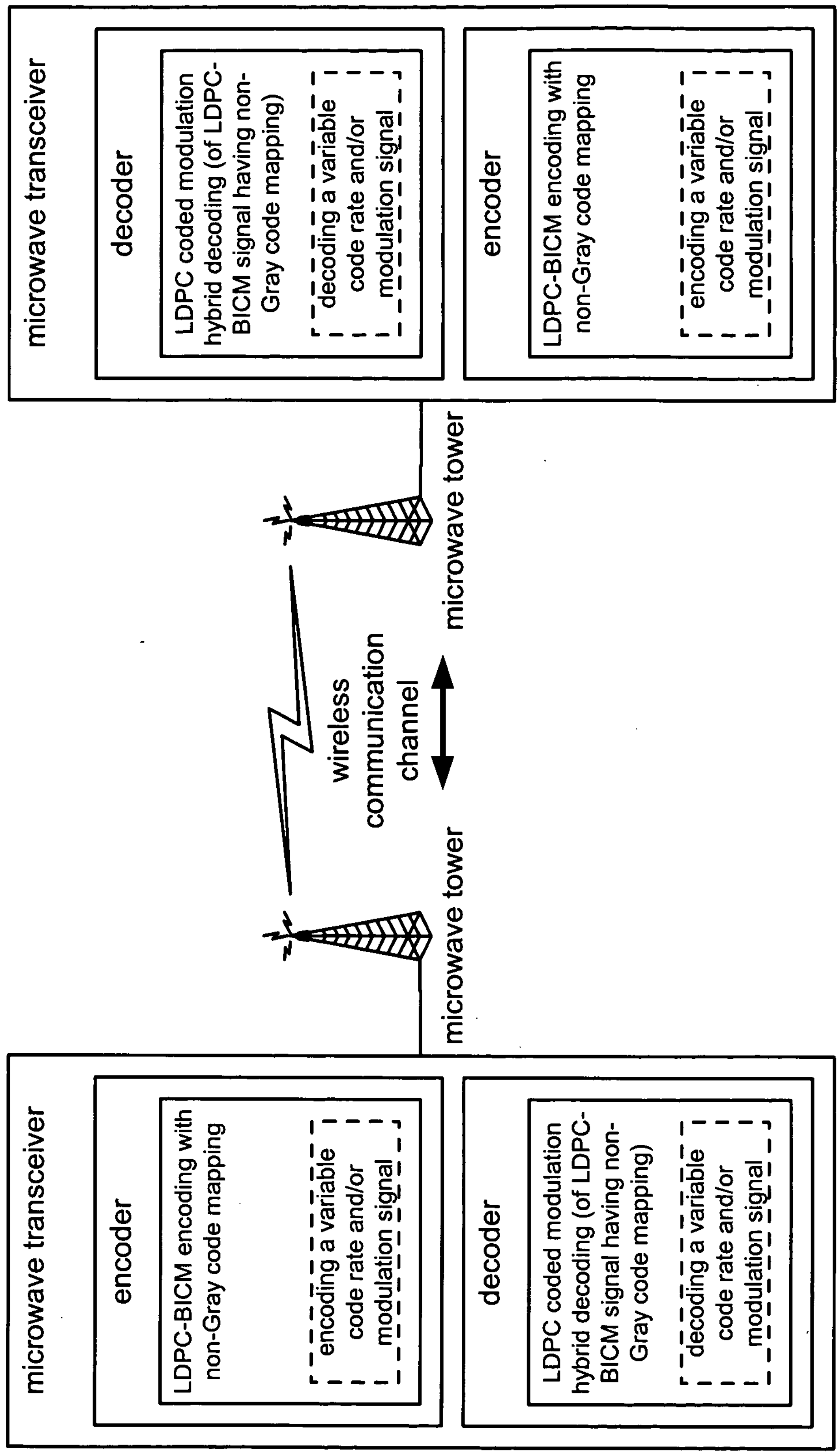
bi-directional cellular communication system

Fig. 4



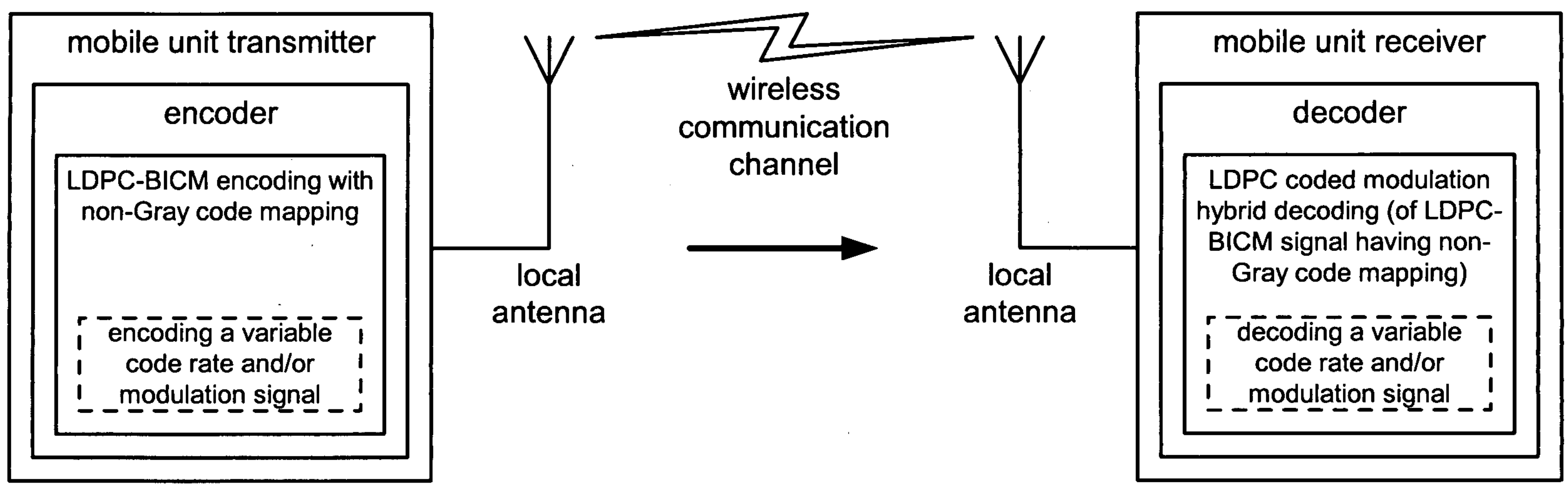
uni-directional microwave communication system

Fig. 5



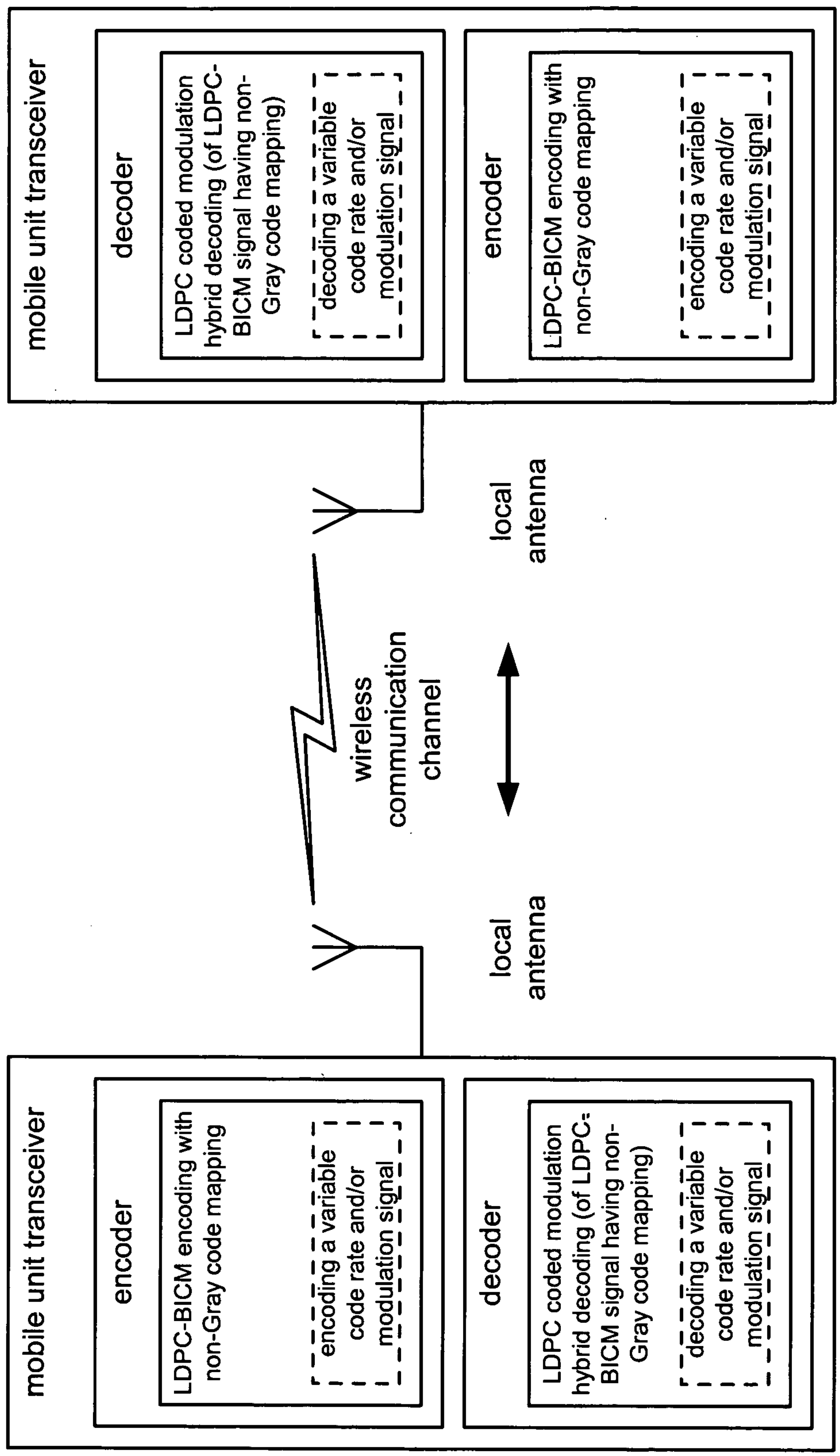
bi-directional microwave communication system

Fig. 6



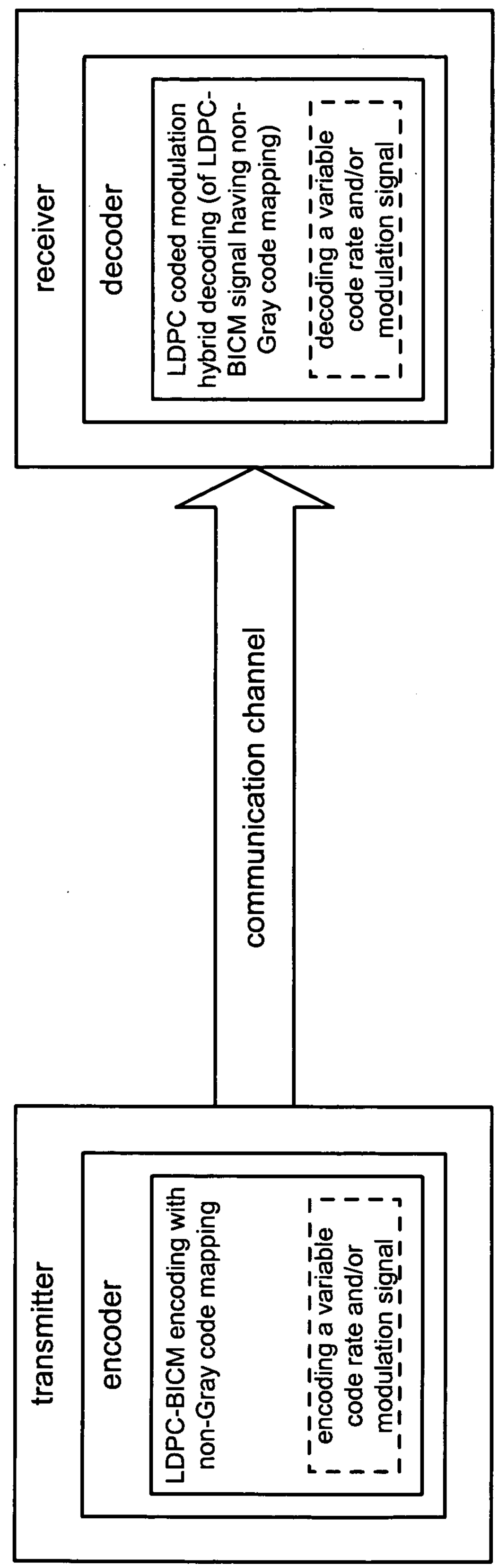
uni-directional point-to-point radio communication system

Fig. 7



bi-directional point-to-point radio communication system

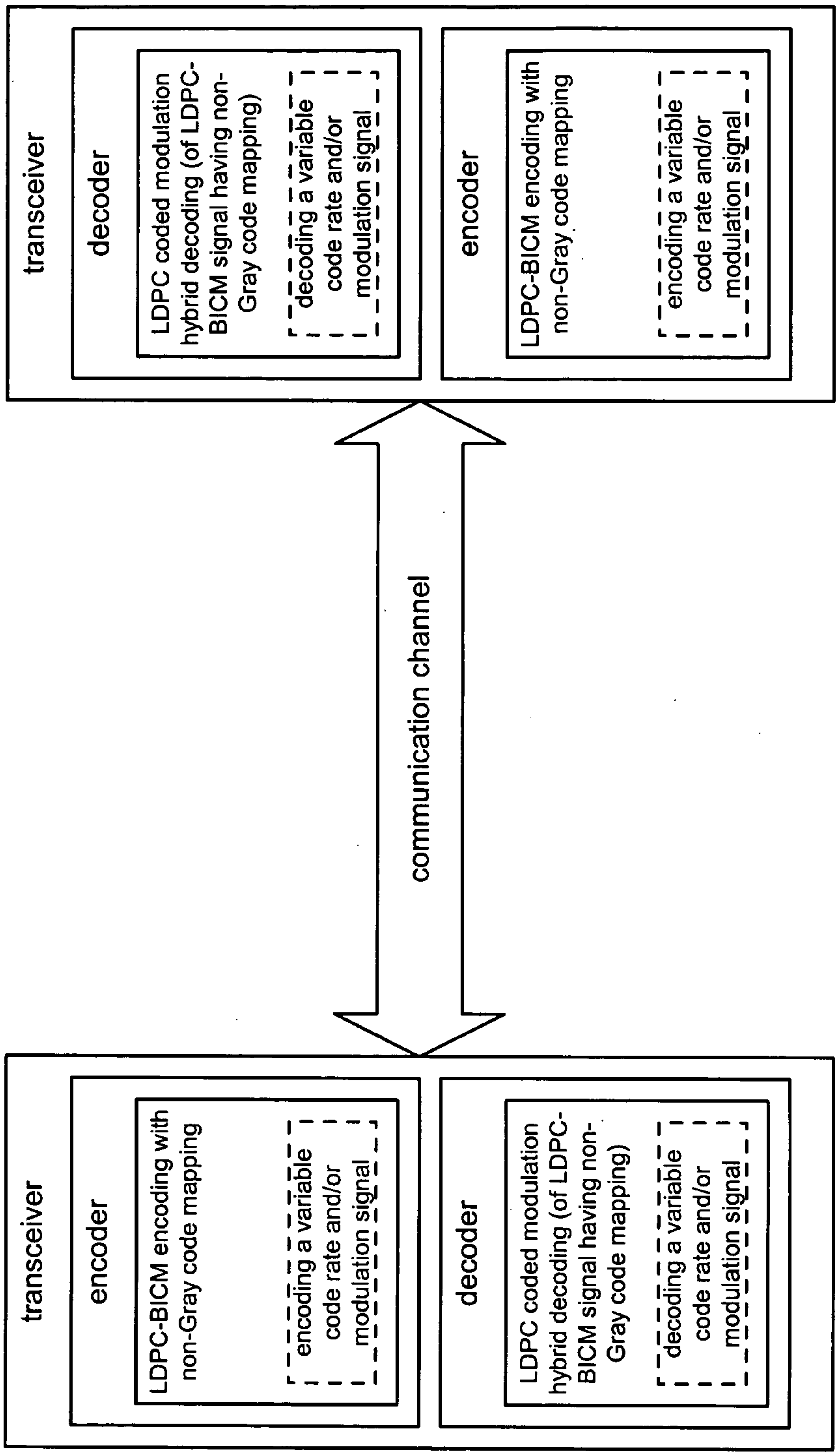
Fig. 8



uni-directional communication system

Fig. 9

Docket No.
BP3134CIP



bi-directional communication system

Fig. 10

Docket No.
BP3134CIP

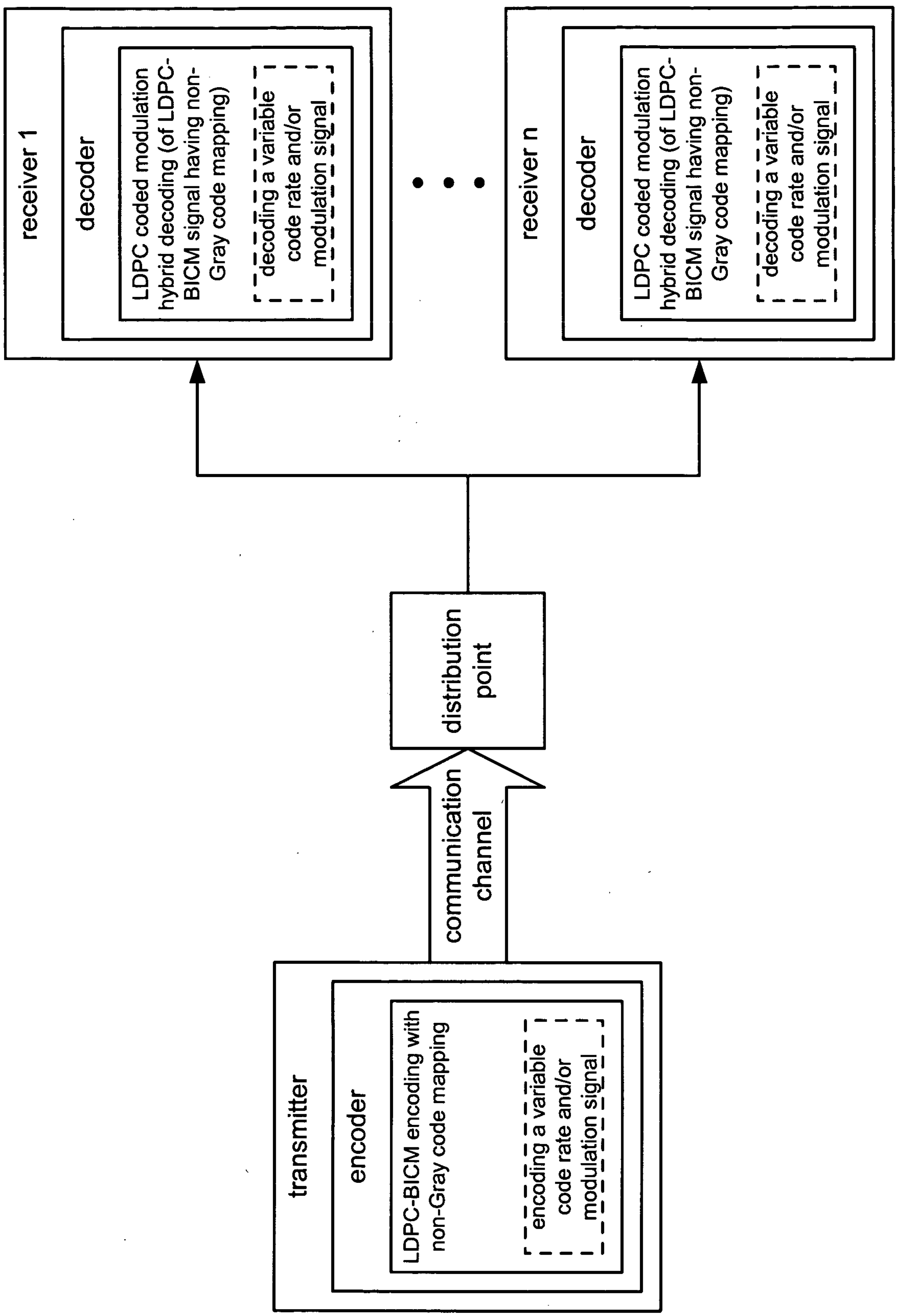
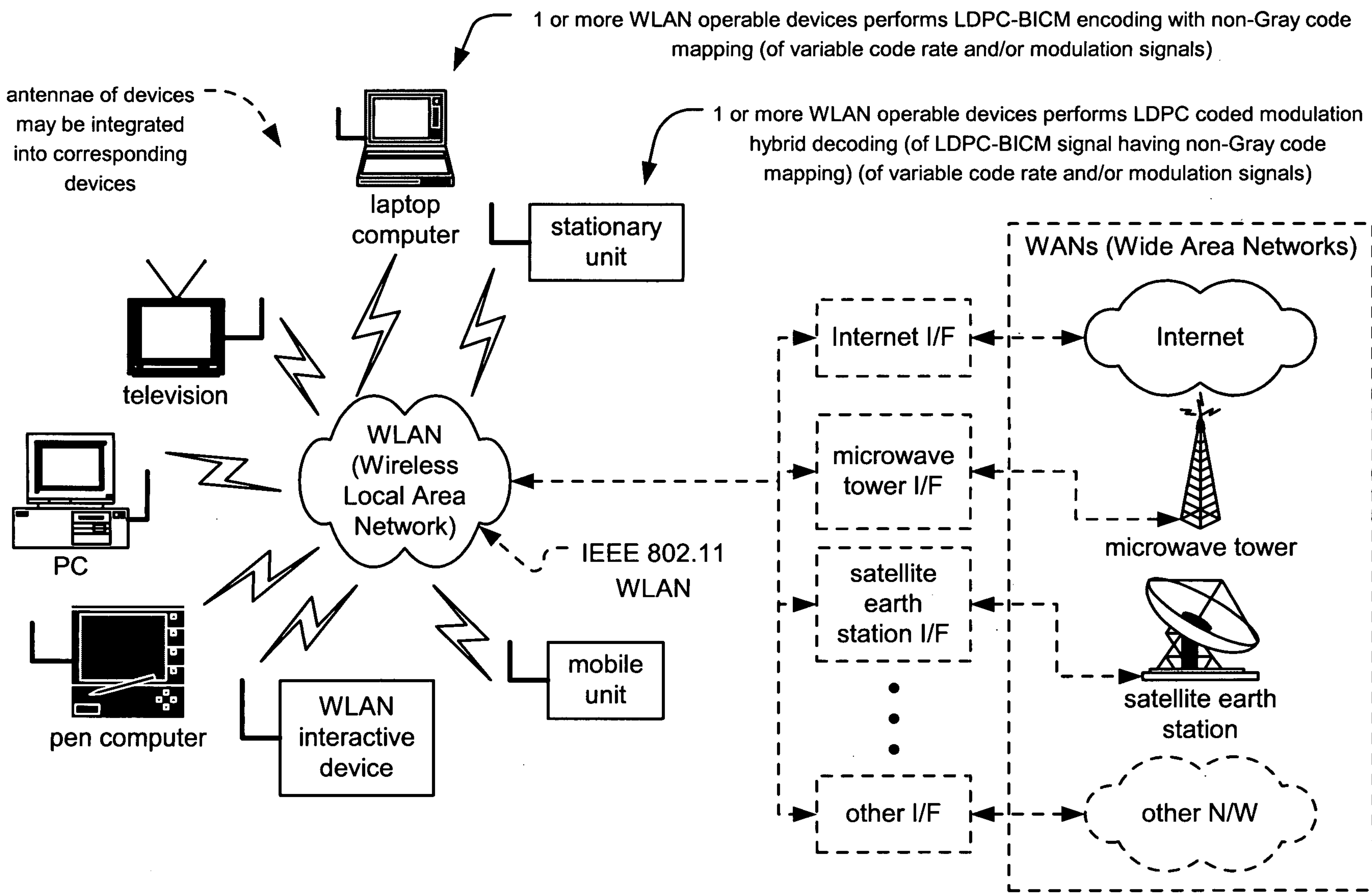
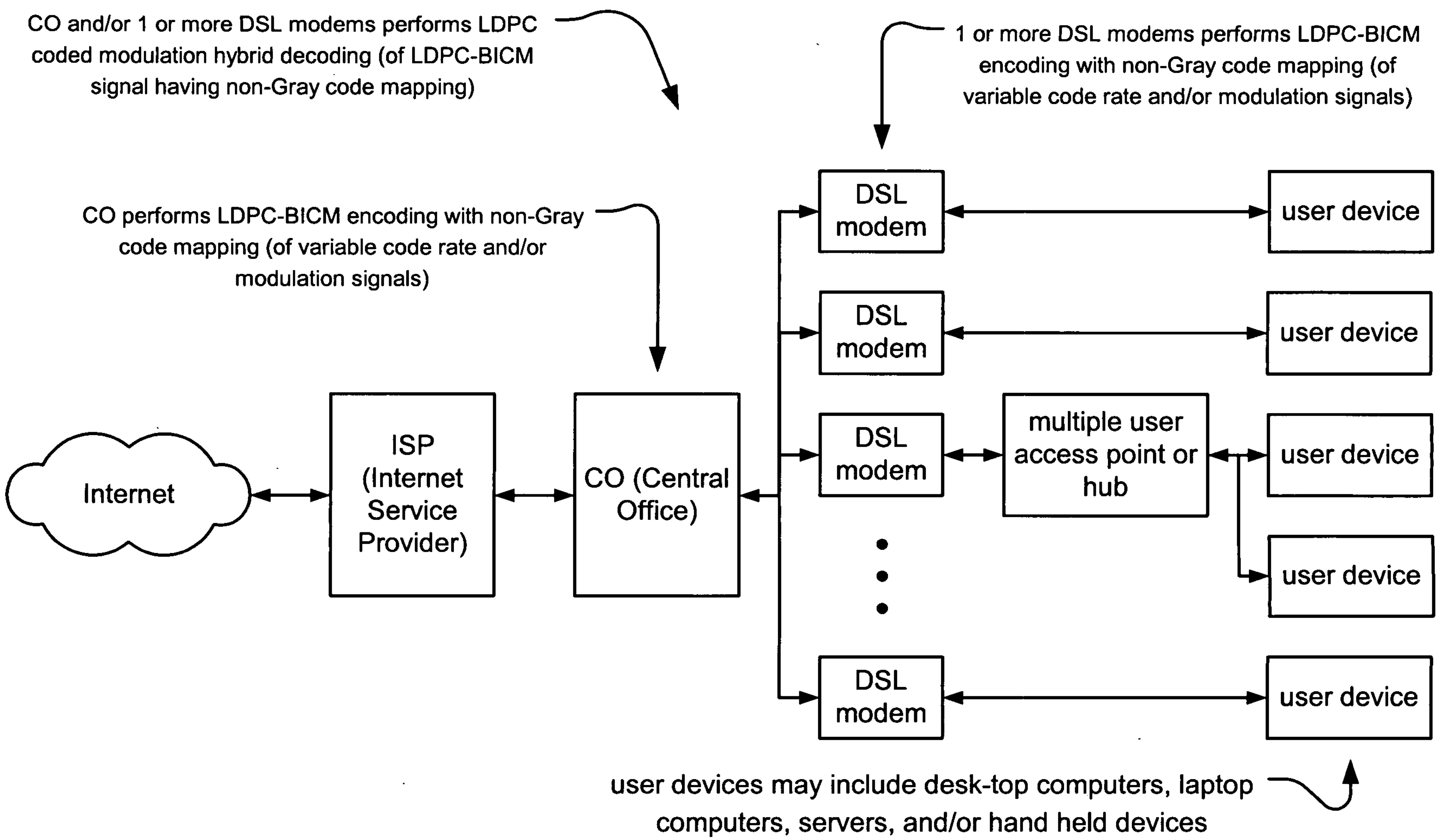


Fig. 11
one to many communication system



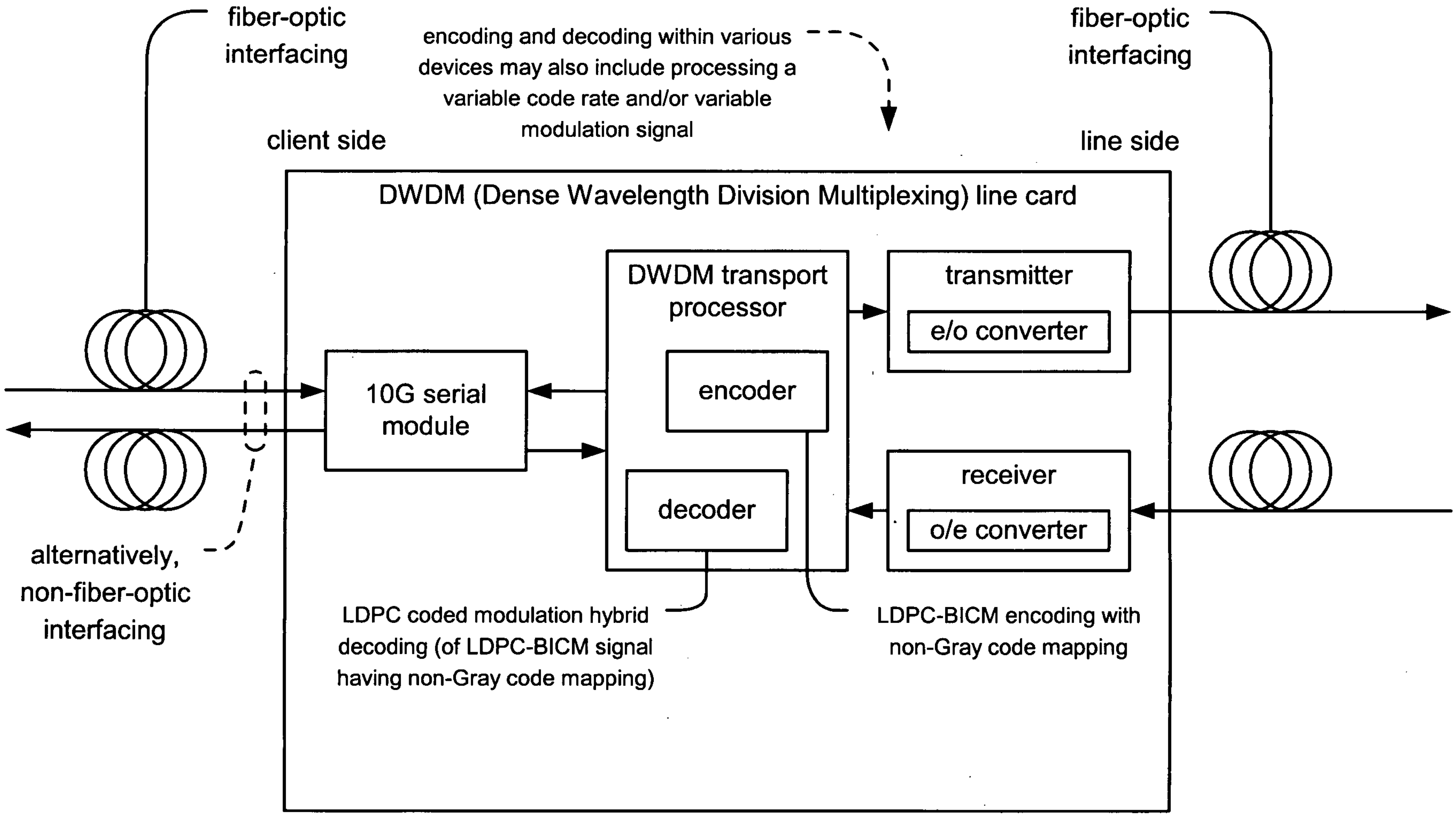
WLAN (Wireless Local Area Network) communication system

Fig. 12



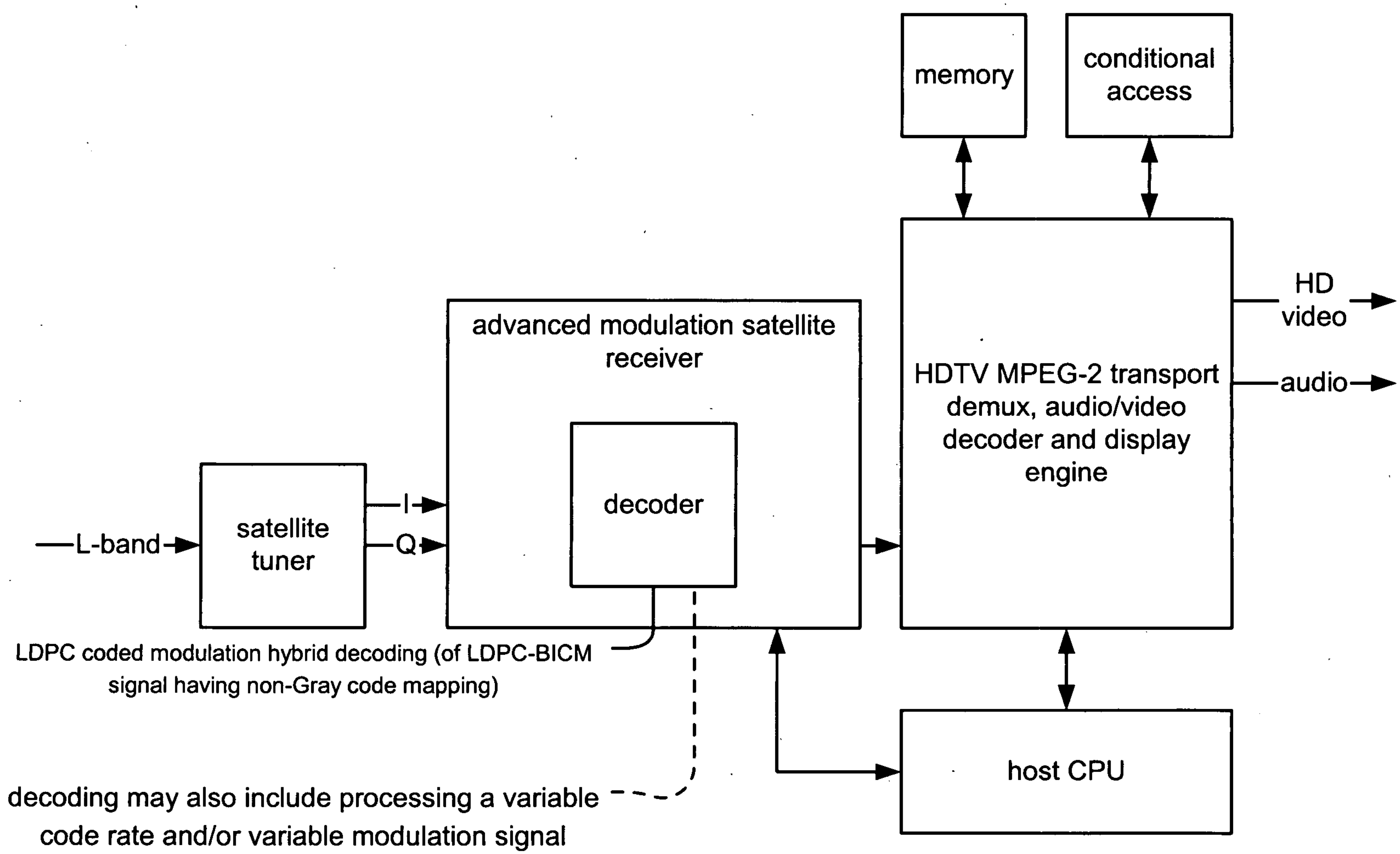
DSL (Digital Subscriber Line) communication system

Fig. 13



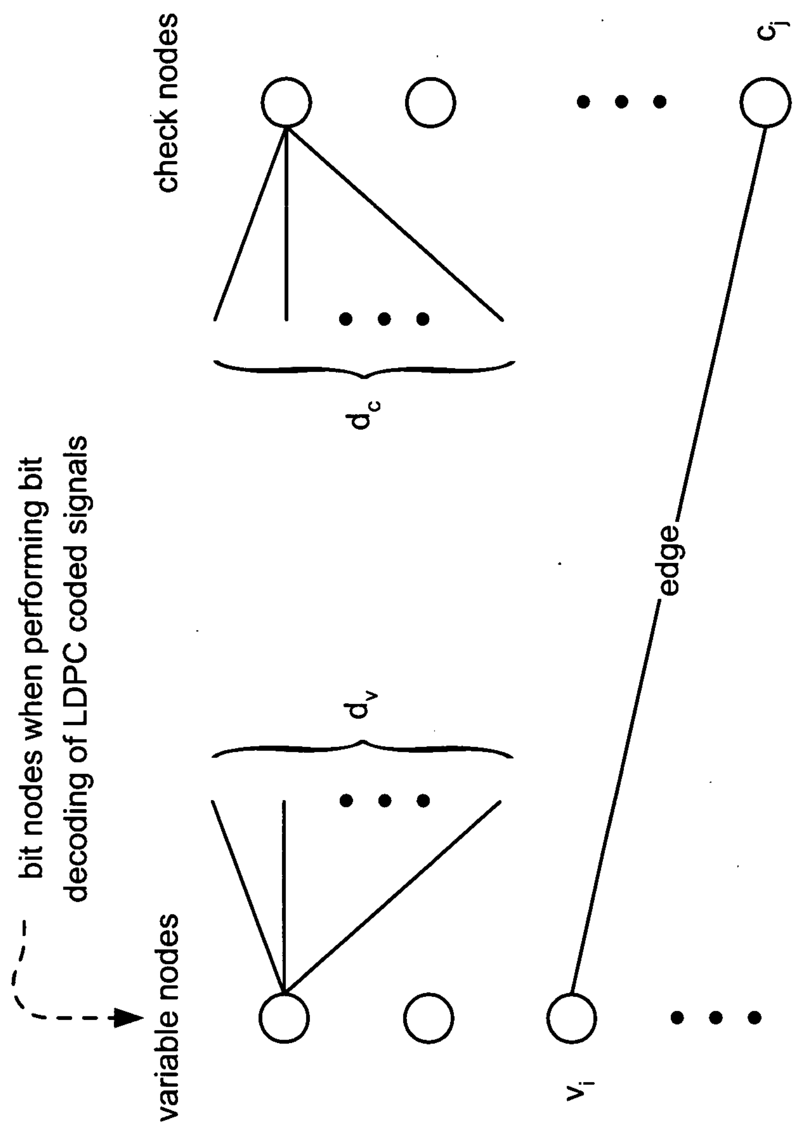
fiber-optic communication system

Fig. 14



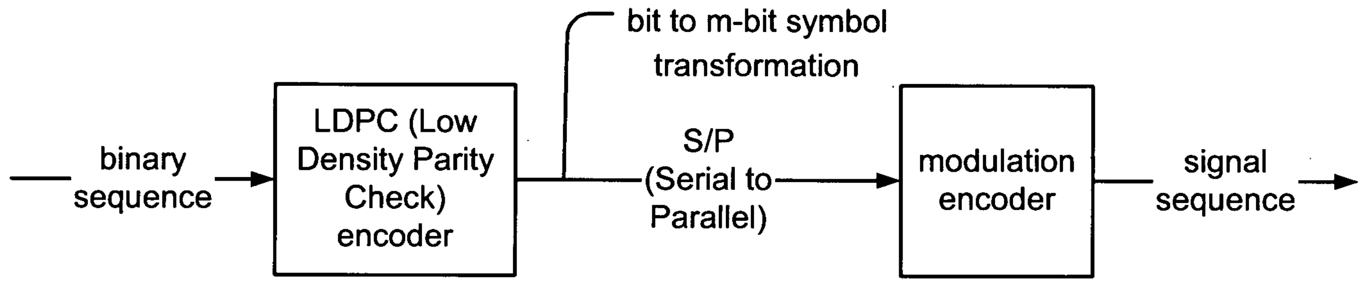
satellite receiver STB (Set Top Box) system

Fig. 15



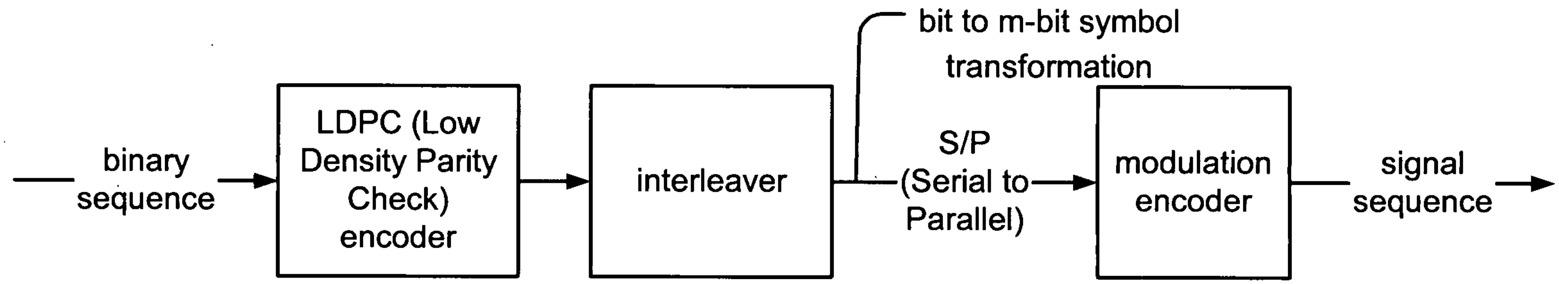
LDPC (Low Density Parity Check) code bipartite graph

Fig. 16



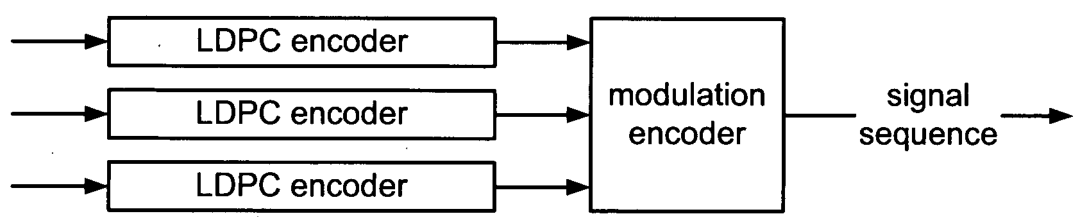
direct combining of LDPC (Low Density Parity Check) coding and modulation

Fig. 17A



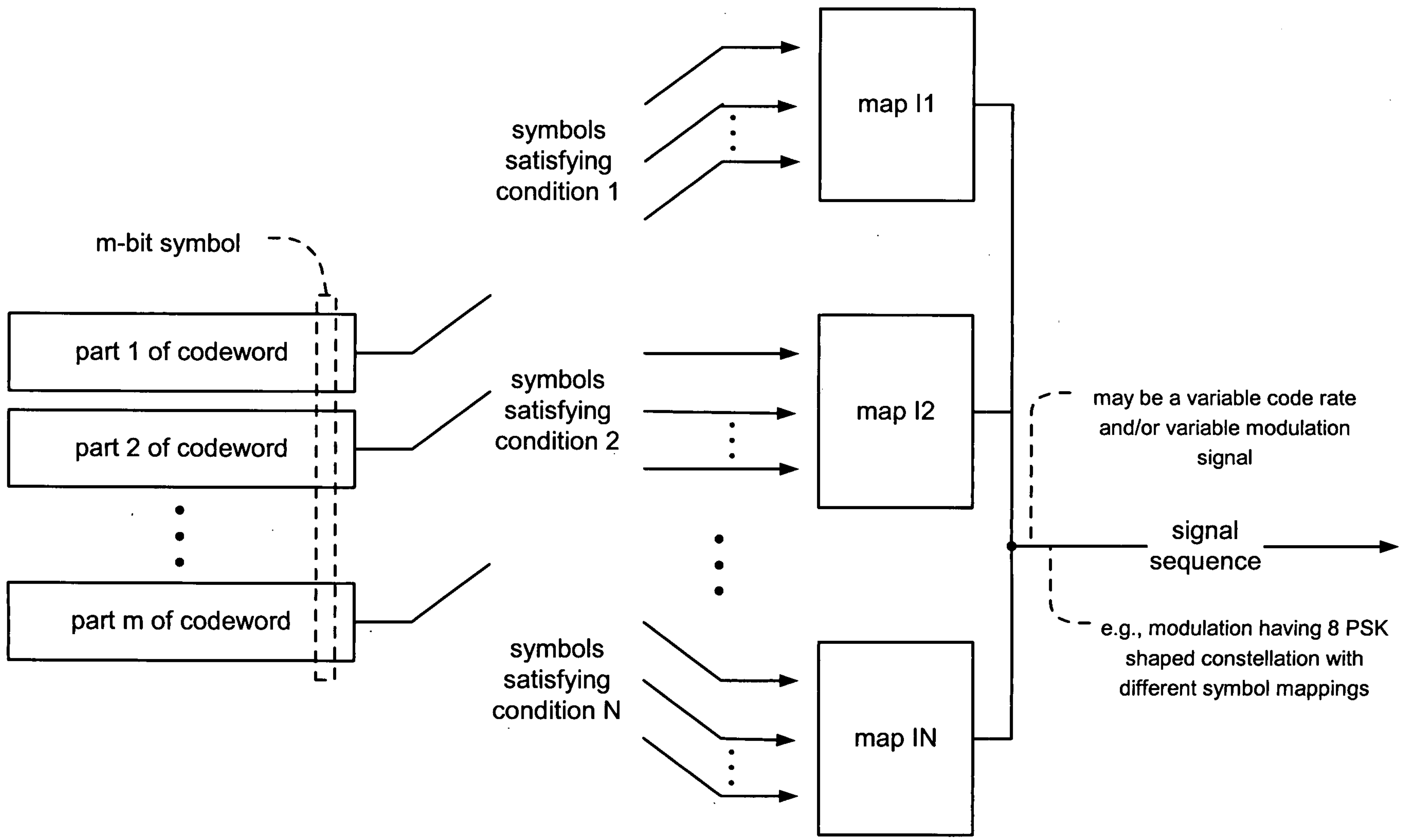
BICM (Bit Interleaved Coded Modulation)

Fig. 17B



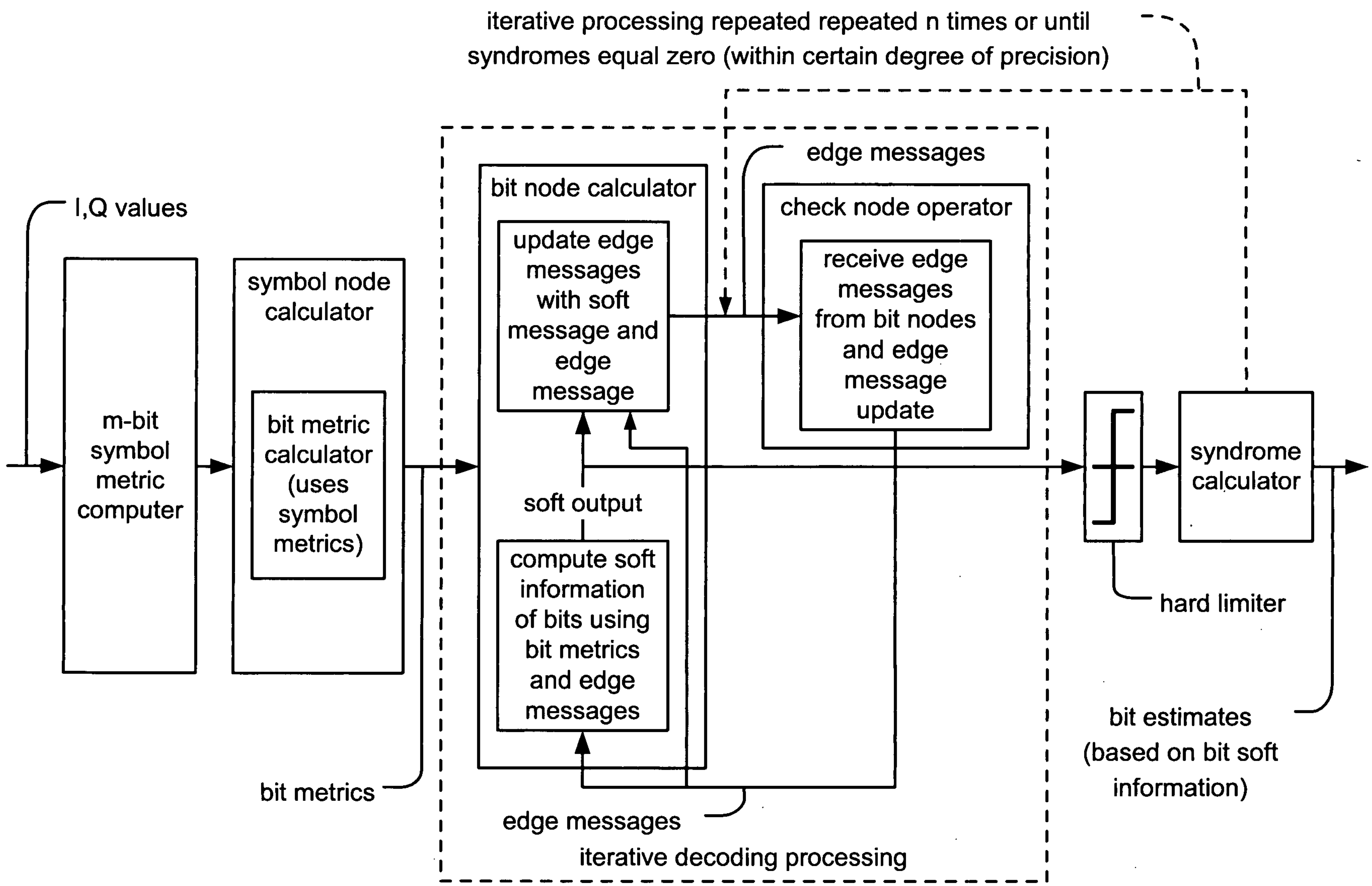
multilevel coded modulation

Fig. 17C



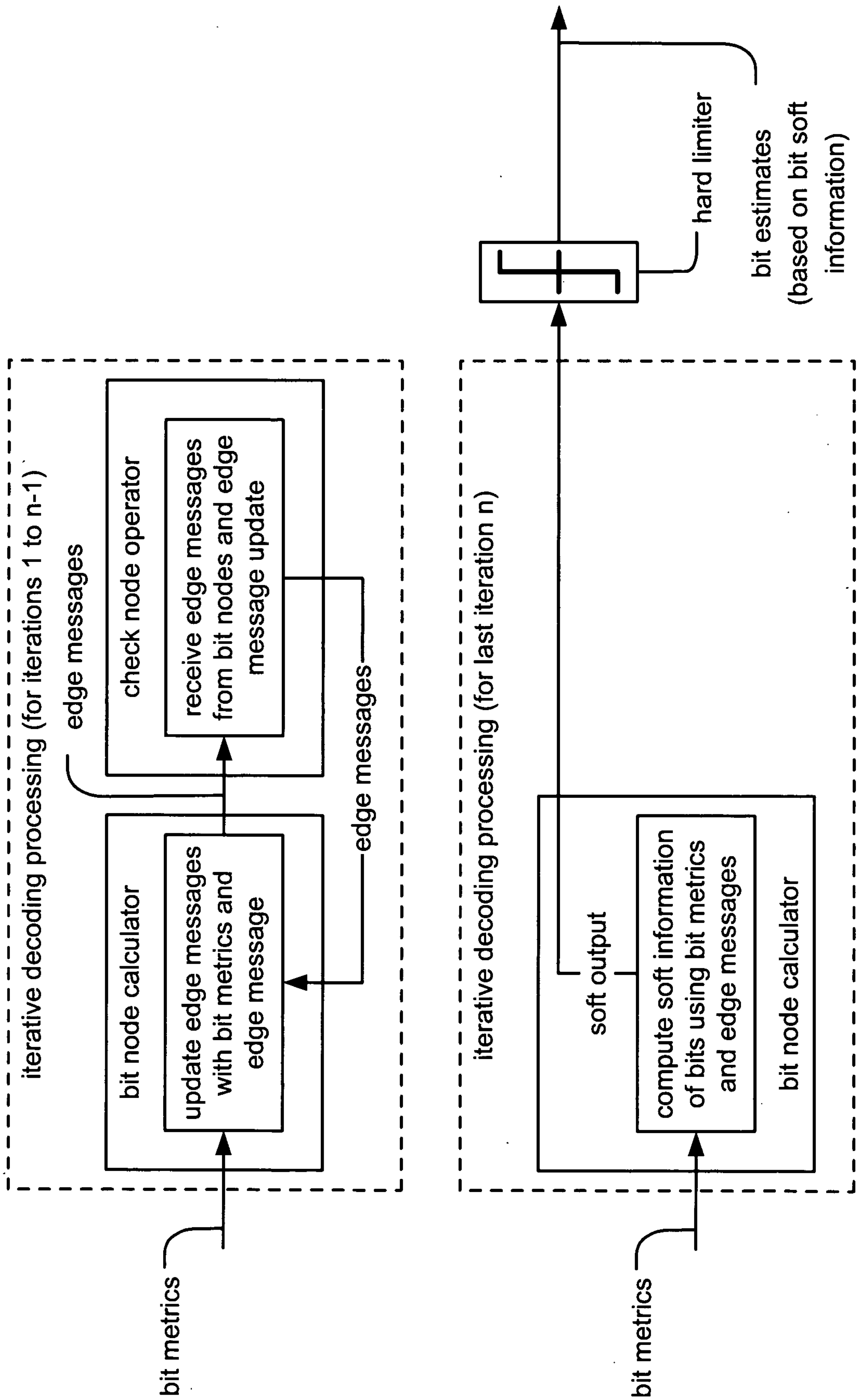
variable signal mapping LDPC (Low Density Parity Check) coded modulation system

Fig. 18



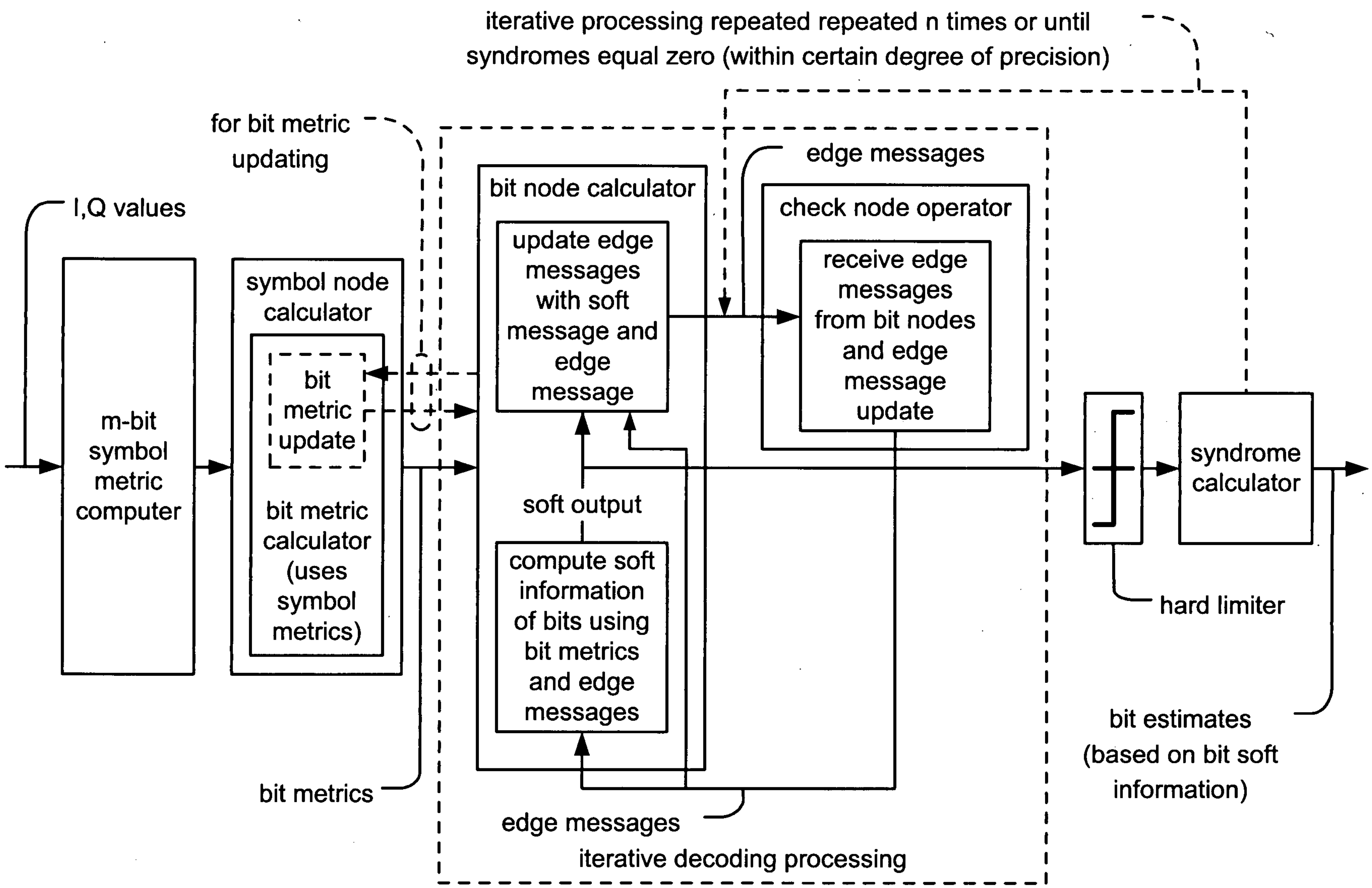
LDPC (Low Density Parity Check) coded modulation decoding functionality using bit metric

Fig. 19



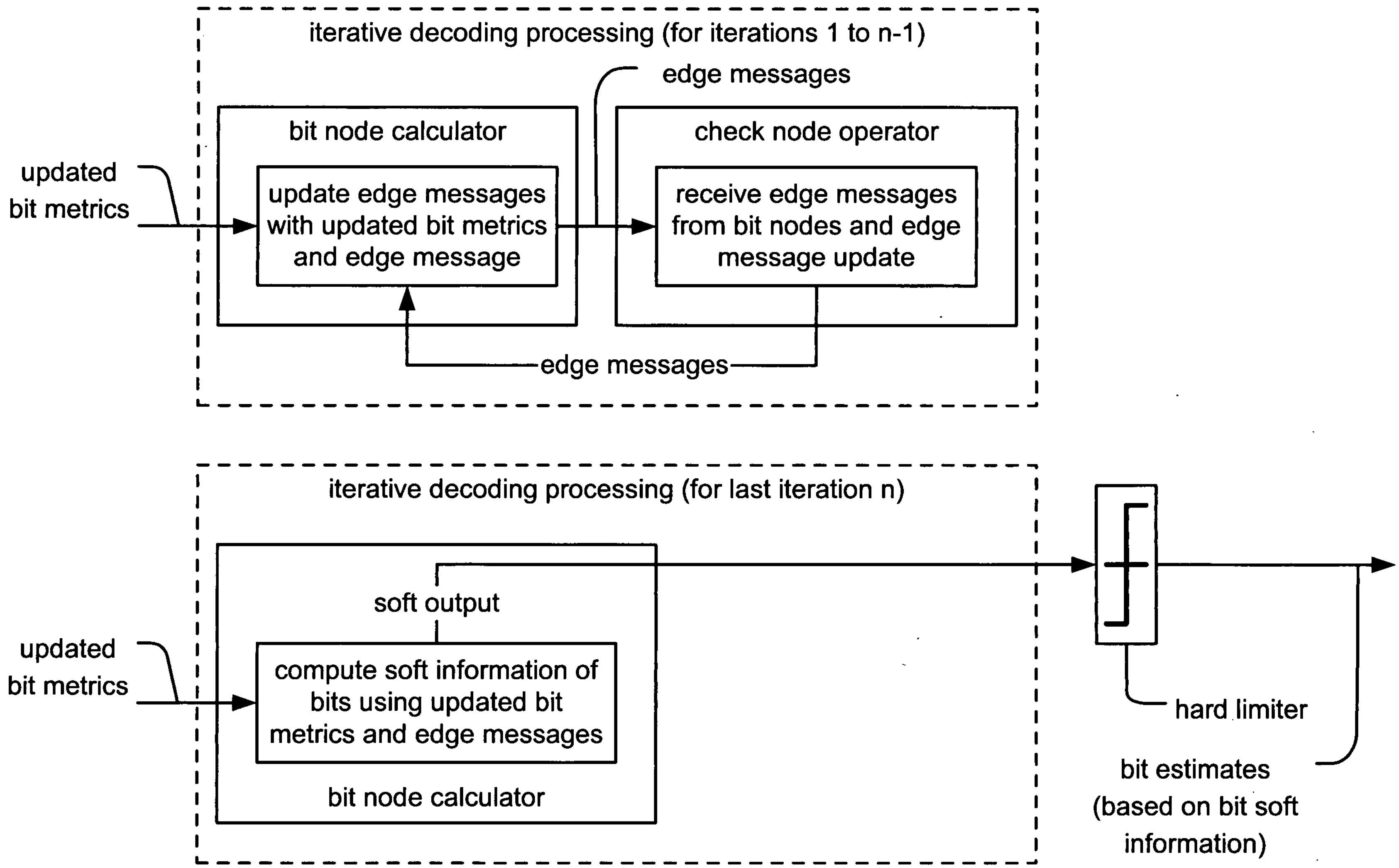
alternative LDPC coded modulation decoding functionality using bit metric (when performing n number of iterations)

Fig. 20



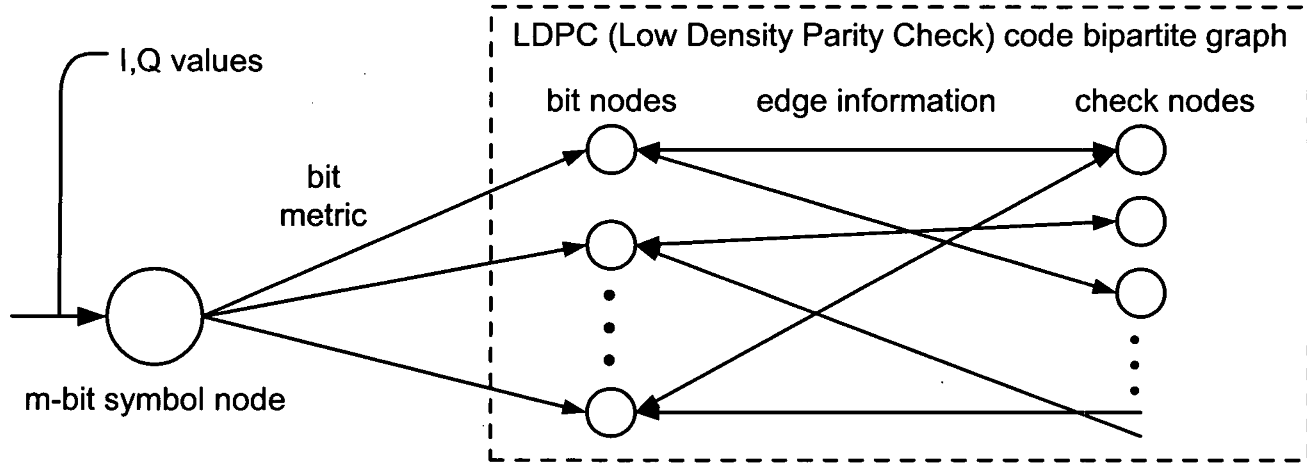
LDPC (Low Density Parity Check) coded modulation decoding functionality using bit metric (with bit metric updating)

Fig. 21



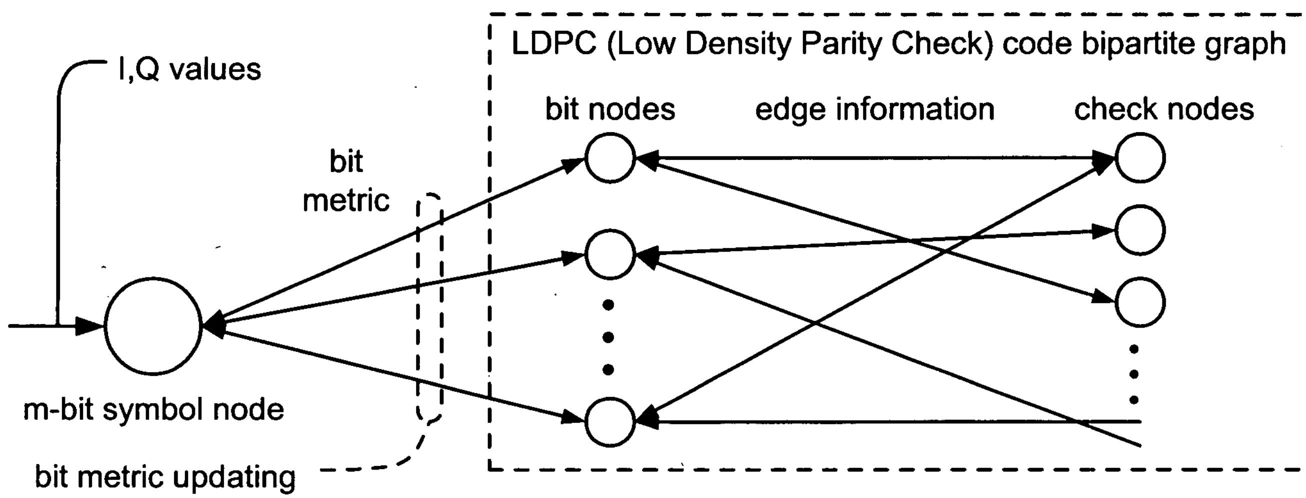
alternative LDPC coded modulation decoding functionality using bit metric (with bit metric updating)
(when performing n number of iterations)

Fig. 22



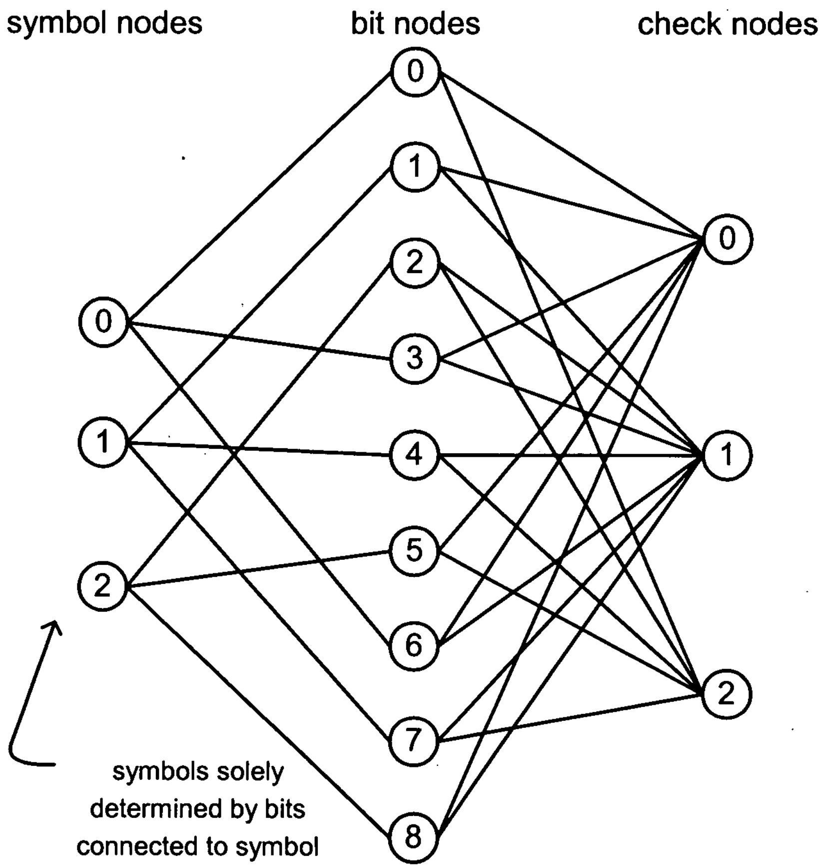
bit decoding using bit metric (shown with respect to LDPC code bipartite graph)

Fig. 23A



bit decoding using bit metric updating (shown with respect to LDPC code bipartite graph)

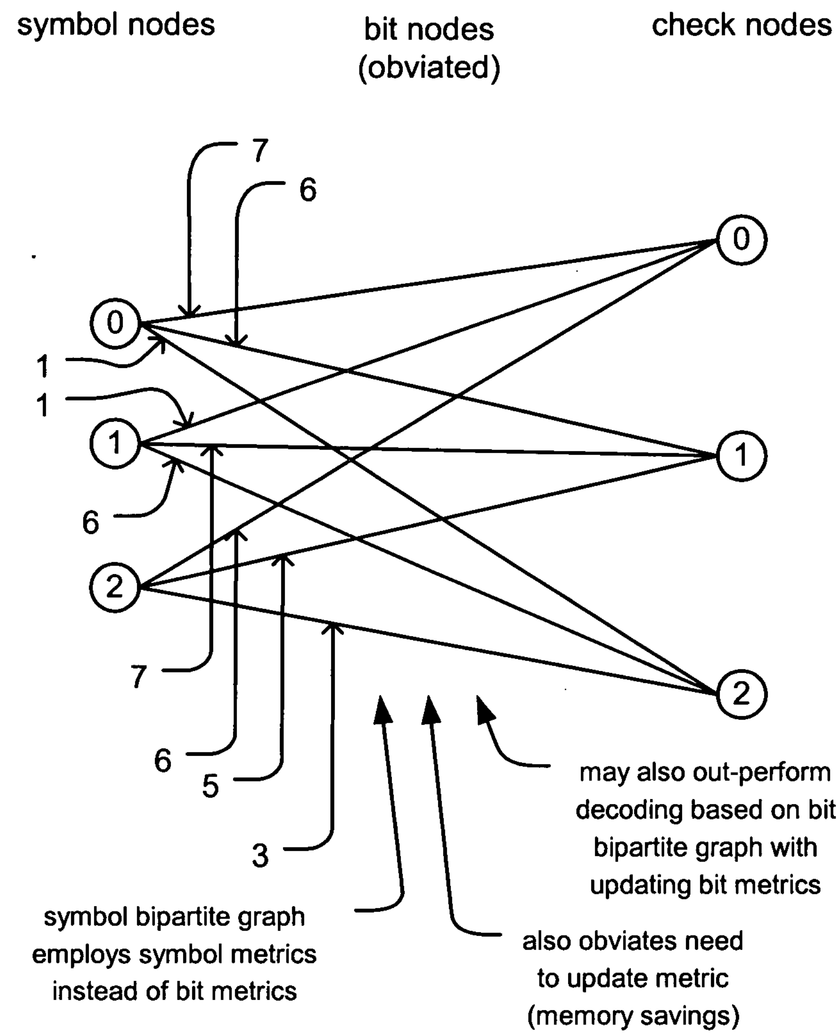
Fig. 23B



$$s_0 \leftrightarrow (b_0, b_3, b_6) \quad s_1 \leftrightarrow (b_1, b_4, b_7)$$
$$s_2 \leftrightarrow (b_2, b_5, b_8) \qquad \text{EQ 1}$$

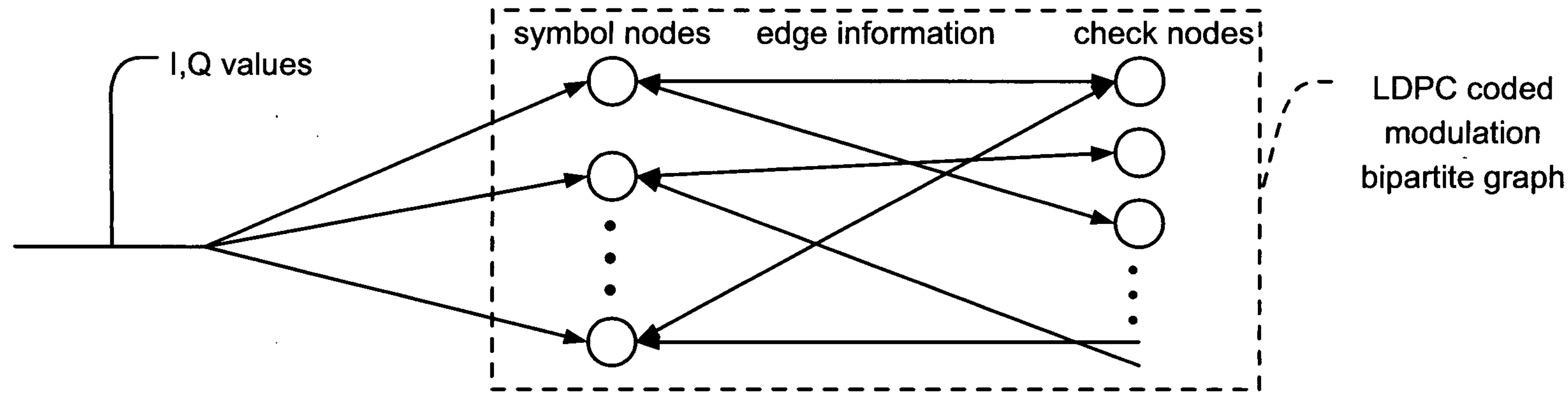
LDPC (Low Density Parity Check) coded modulation tripartite graph (or bit bipartite graph) with symbol nodes connected to bit nodes

Fig. 24A



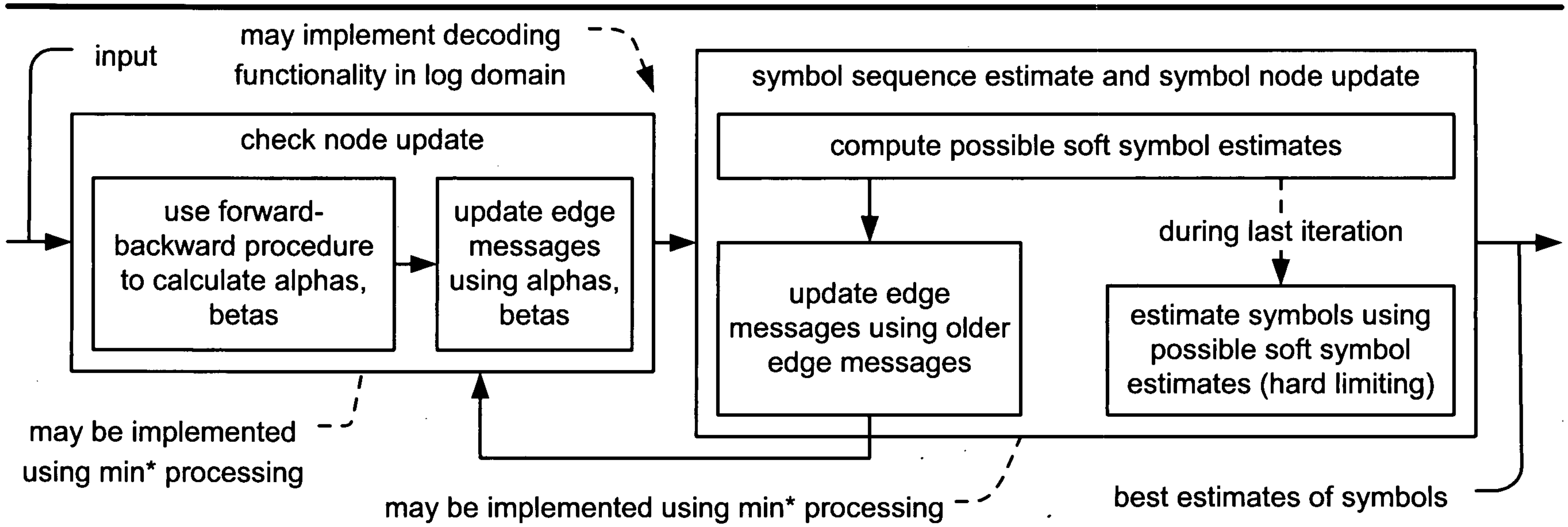
LDPC coded modulation bipartite graph (or symbol bipartite graph) with symbol nodes connected directly to check nodes (with labeled edges)

Fig. 24B



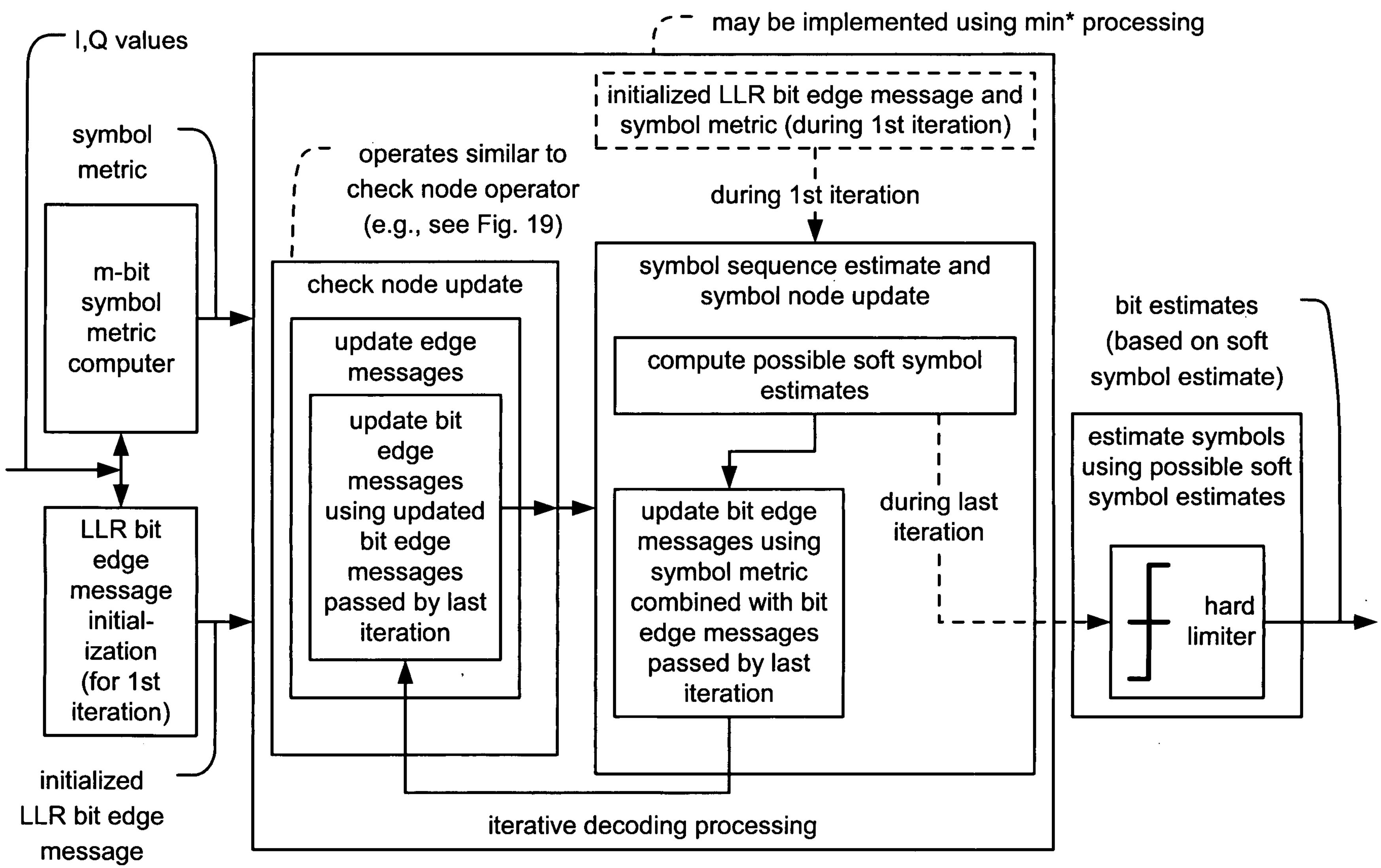
symbol decoding (shown with respect to LDPC (Low Density Parity Check) coded modulation bipartite graph)

Fig. 25A



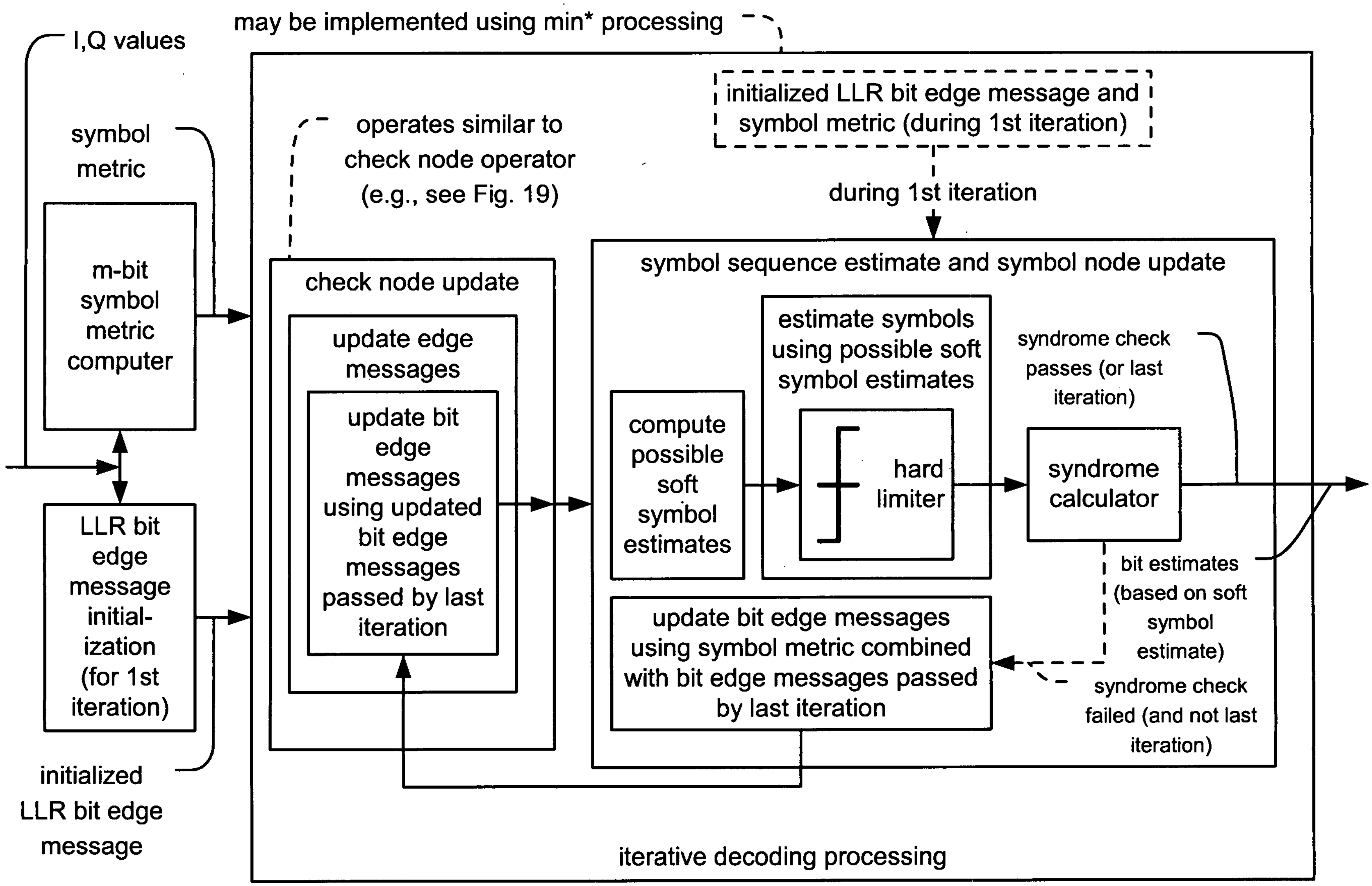
symbol decoding functionality (supported with LDPC (Low Density Parity Check) coded modulation bipartite graph)

Fig. 25B



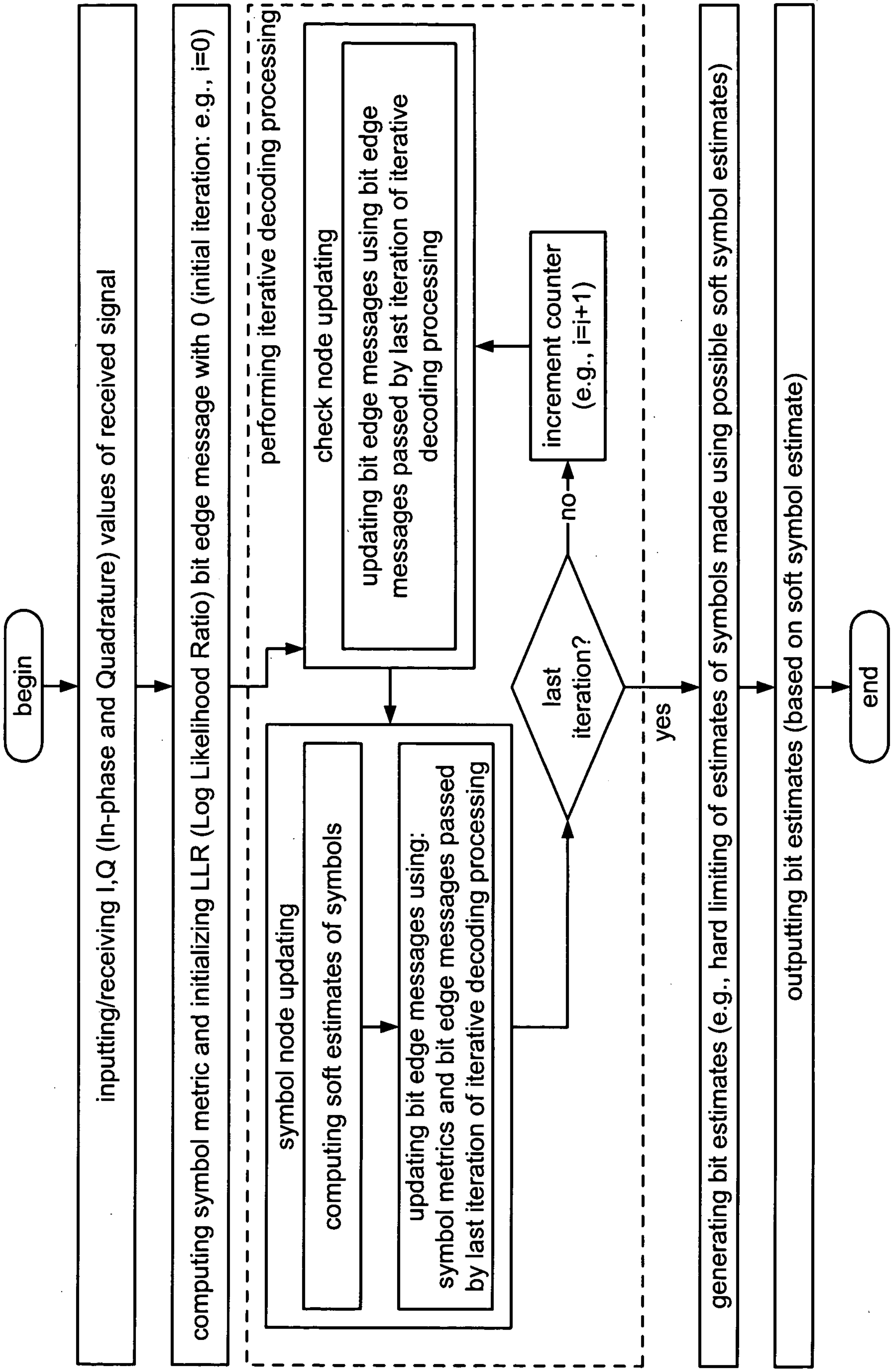
hybrid decoding functionality (having reduced complexity of symbol decoding) of LDPC coded modulation signals

Fig. 26



hybrid decoding functionality (having reduced complexity of symbol decoding) of LDPC coded modulation signals

Fig. 27



method for hybrid decoding of LDPC coded modulation signals

Fig. 28

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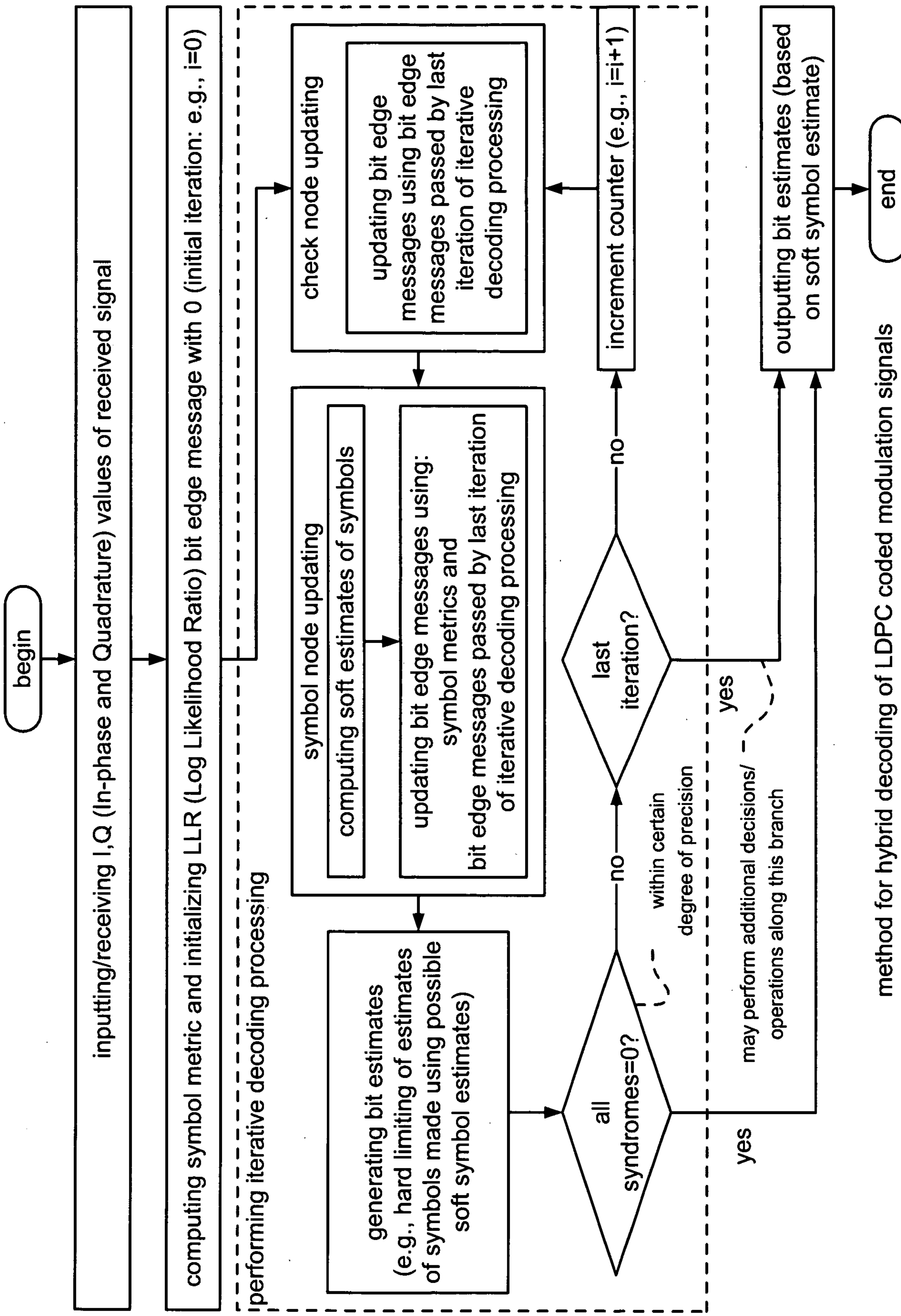
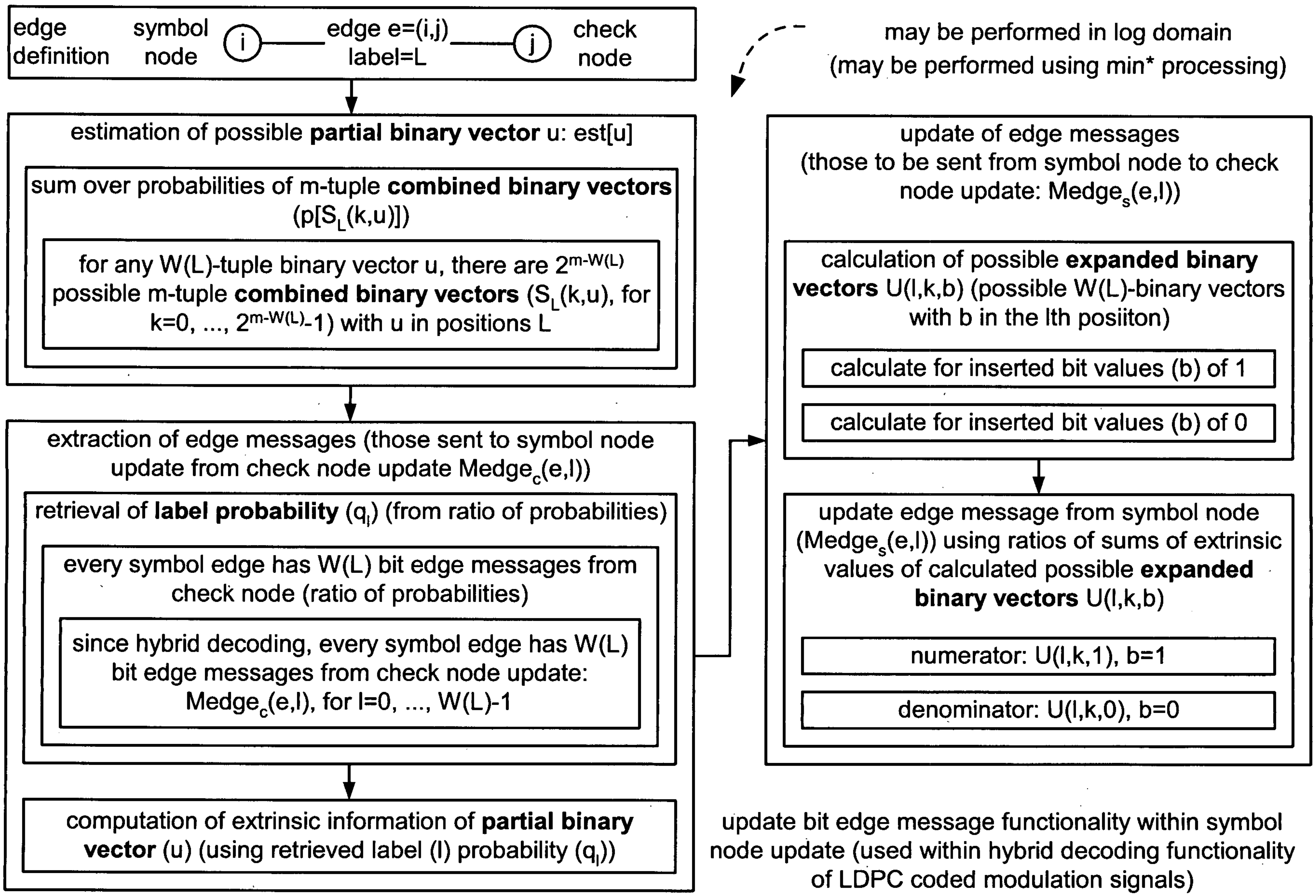


method for hybrid decoding of LDPC coded modulation signals

Fig. 29



update bit edge message functionality within symbol node update (used within hybrid decoding functionality of LDPC coded modulation signals)

Fig. 30

definition of label in symbol bipartite graph

label binary vector is m-bit binary vector: $L=(L_{m-1},\ldots,L_0)$, where $W(L)$ is the Hamming weight

↓

this dictates that in the m-bit binary vector L, m-W(L) positions have value 0

↓

definition of zero (Z(L)) and non-zero (NZ(L)) position vectors

$Z(L)=(Z_{m-W(L)-1},\ldots,Z_0)$, where L_{Zi} is 0 in L and $Z_i<Z_j$ if $i<j$

$NZ(L)=(NZ_{W(L)-1},\ldots,NZ_0)$, where $NZ_i<NZ_j$ if $i<j$

↓

generation of **combined binary vector** ($S_L(k,u)$)

for every possible W(L)-tuple **partial binary vector** (u) and every possible **remaining binary vector** (k), the **combined binary vector** ($S_L(k,u)$) in an m-tuple vector $S=(S_m,\ldots,S_0)$

partial binary vector: $u=(S_{NZ(W(L)-1)}, \ldots, S_{NZ(0)})$

remaining binary vector: $k=(S_{Z(m-W(L)-1)}, \ldots, S_{Z(0)})$

combined binary vector generation

Fig. 31

generation of **expanded binary vector** (U(l,k,b))

expanded binary vector (U(l,k,b)) may be represented as a binary vector with b in the position l and (k_{l-2}, ..., k_0) in the first l-1 position and ($k_{W(L)-2}$, ..., k_{l-1}) in the last (W(L)-1) position

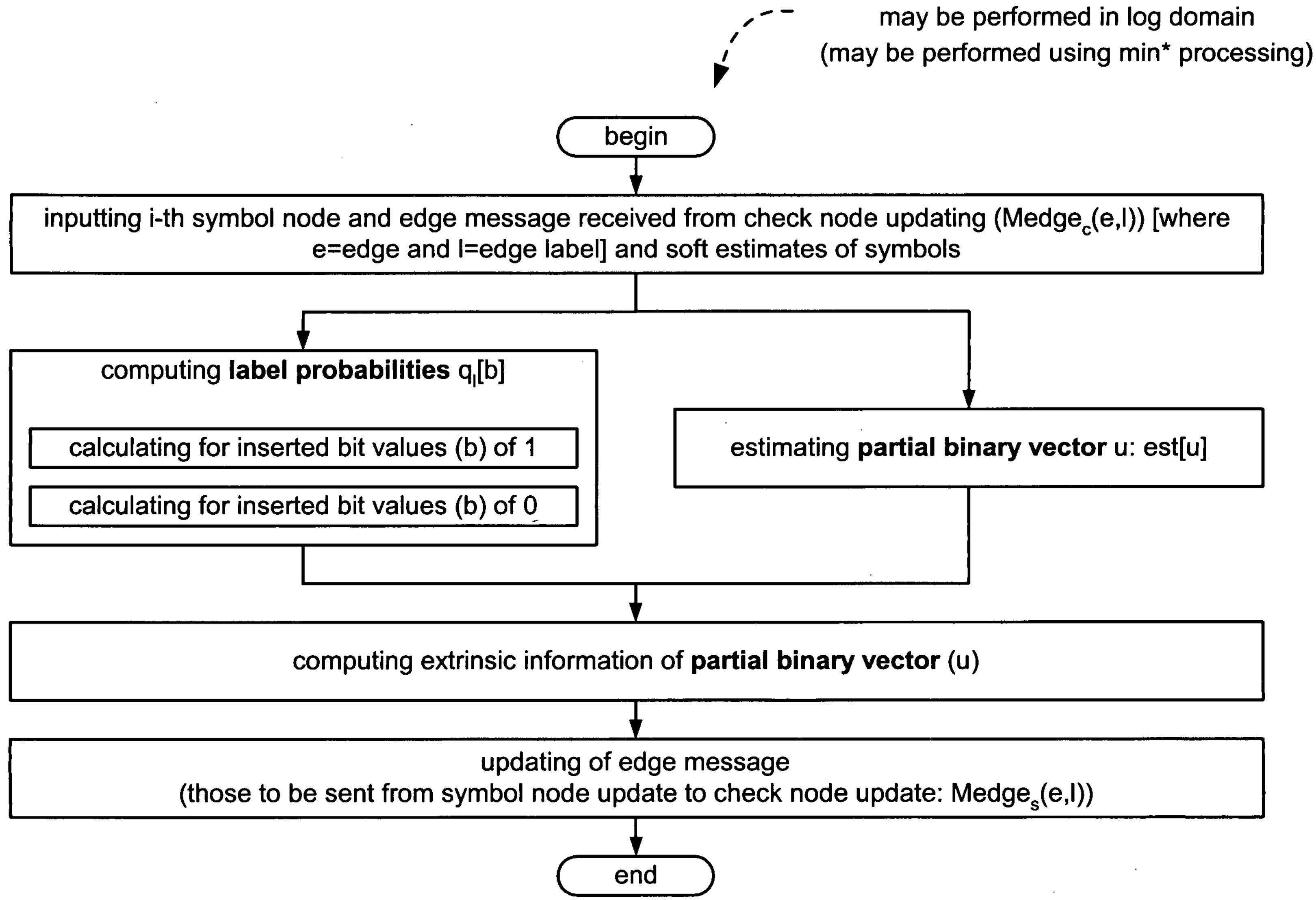
for any W(L), only one **expanded binary vector** (U(l,k,b)) such that U(l,k,b)=(0,0,b)

example: W(L)=3, for any bit b and any k=(k_1,k_0)

U(0,k,b)=(k_1,k_0,b)	U(1,k,b)=(k_1,b,k_0)	U(2,k,b)=(b,k_1,k_0)

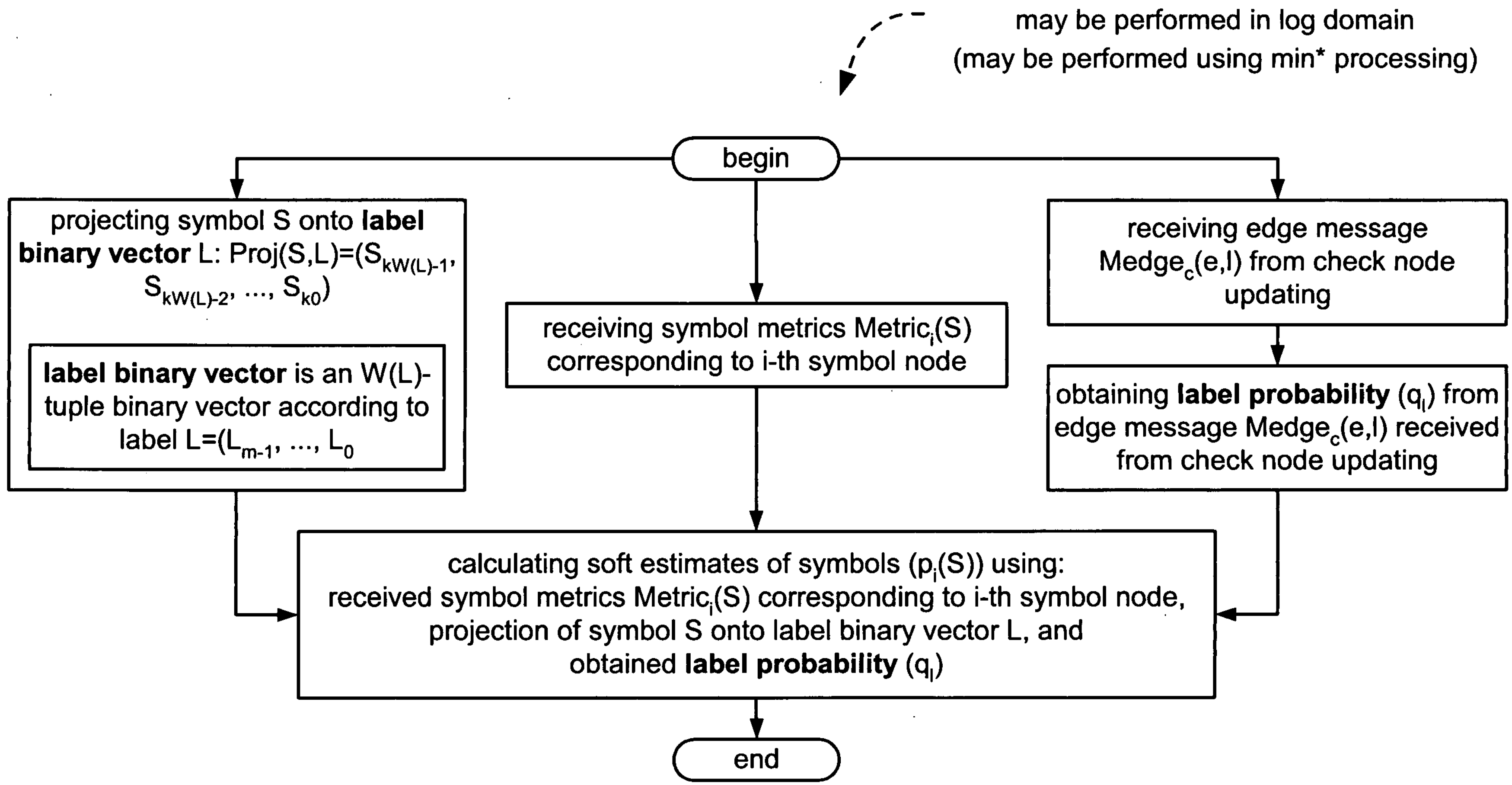
expanded binary vector generation

Fig. 32



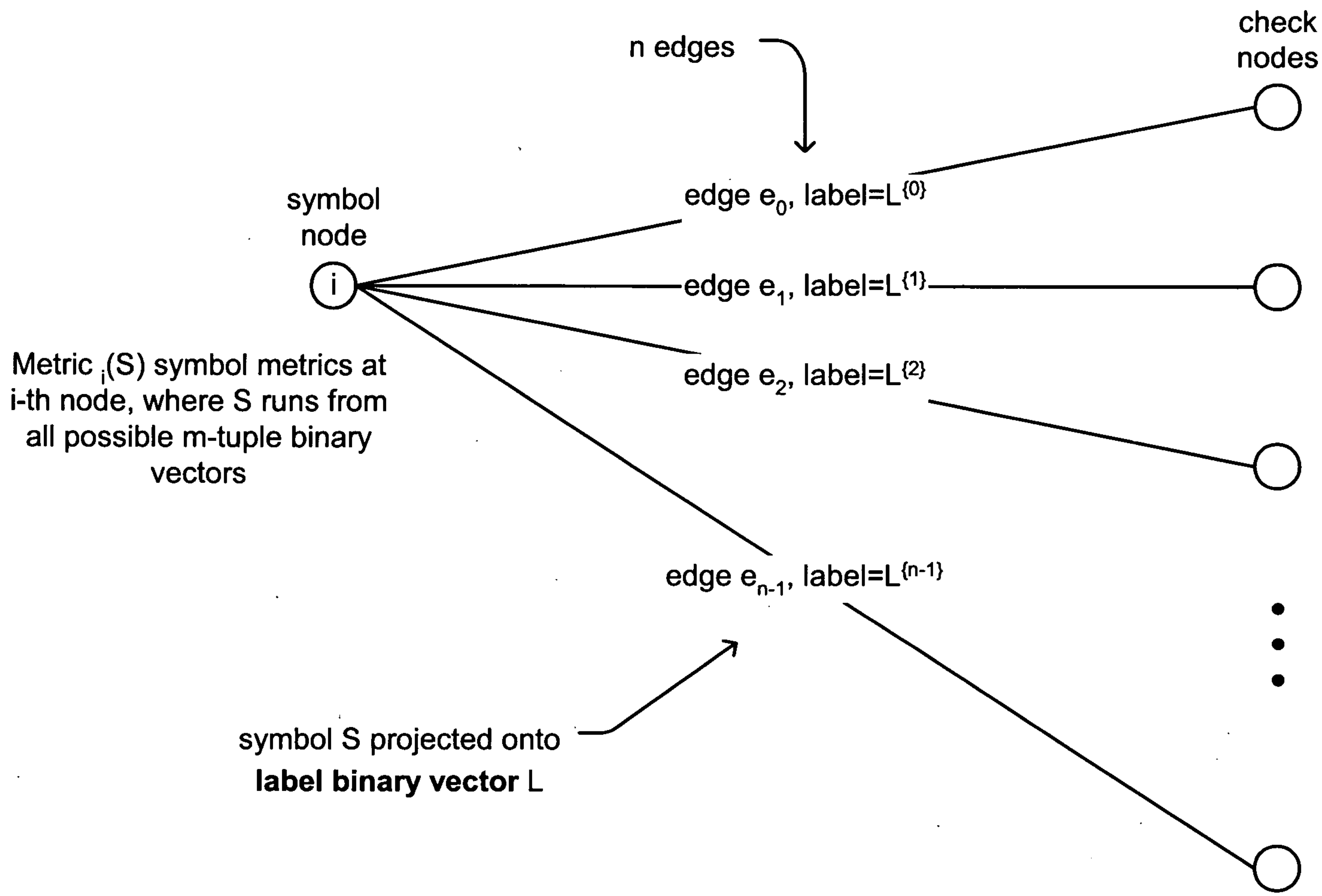
method for updating edge messages (within symbol node updating)

Fig. 33



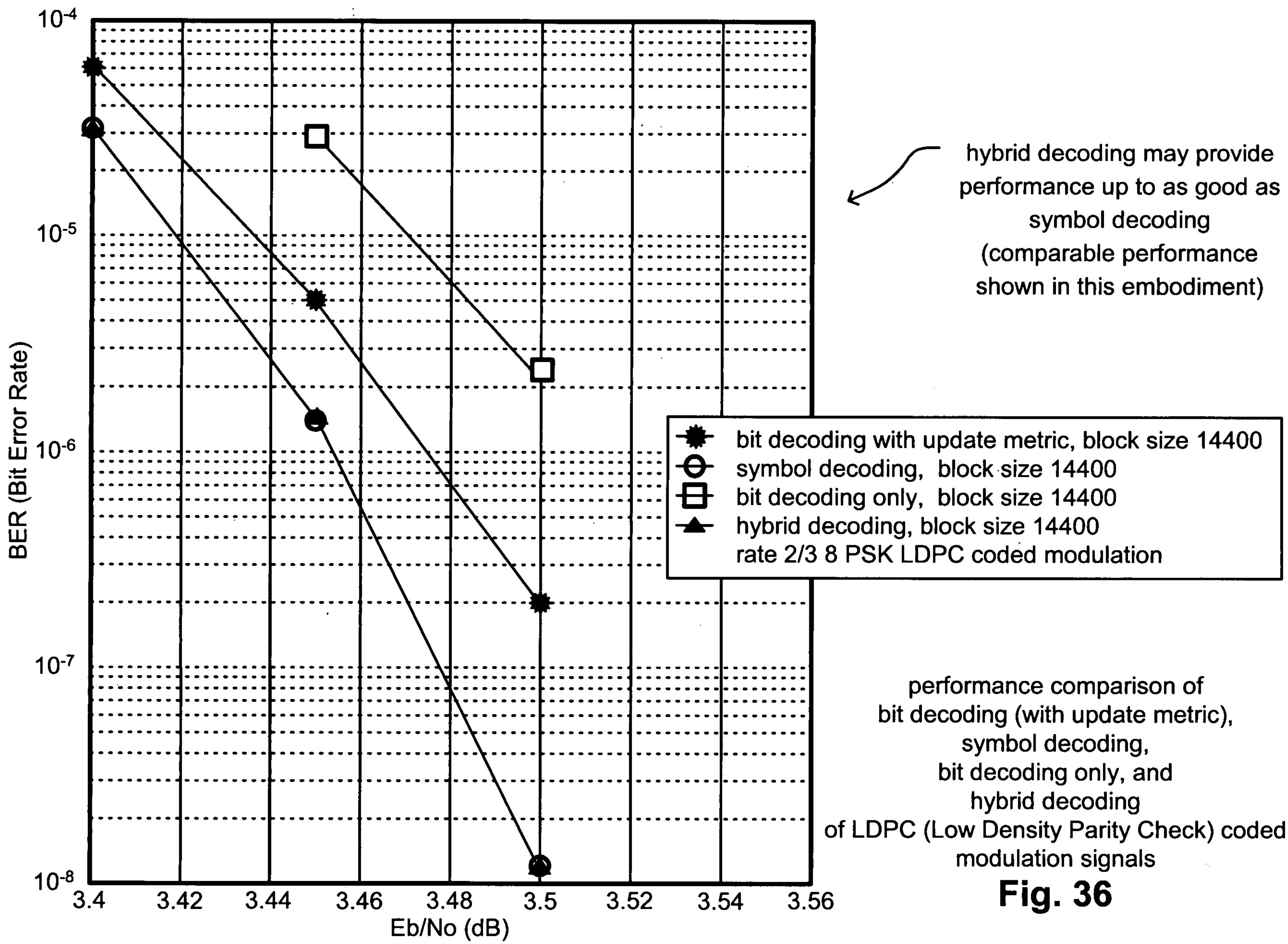
method for calculating soft estimates of symbols (within symbol node updating)

Fig. 34



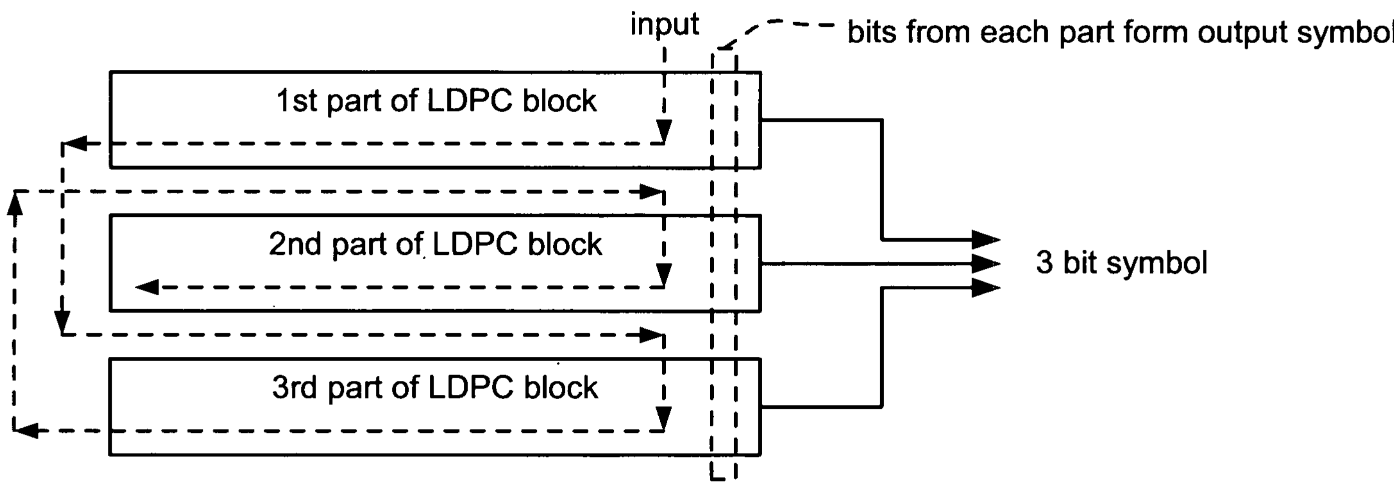
projection of symbol onto label binary vector

Fig. 35



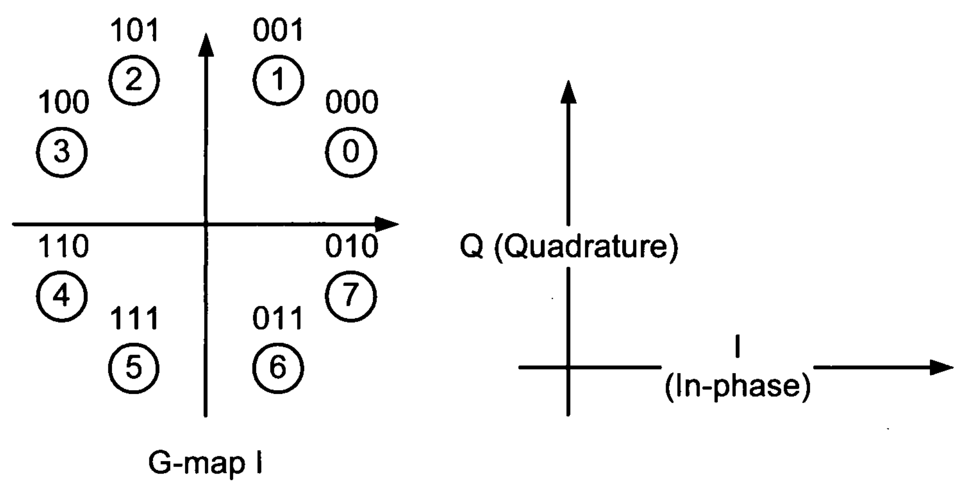
performance comparison of
bit decoding (with update metric),
symbol decoding,
bit decoding only, and
hybrid decoding
of LDPC (Low Density Parity Check) coded
modulation signals

Fig. 36



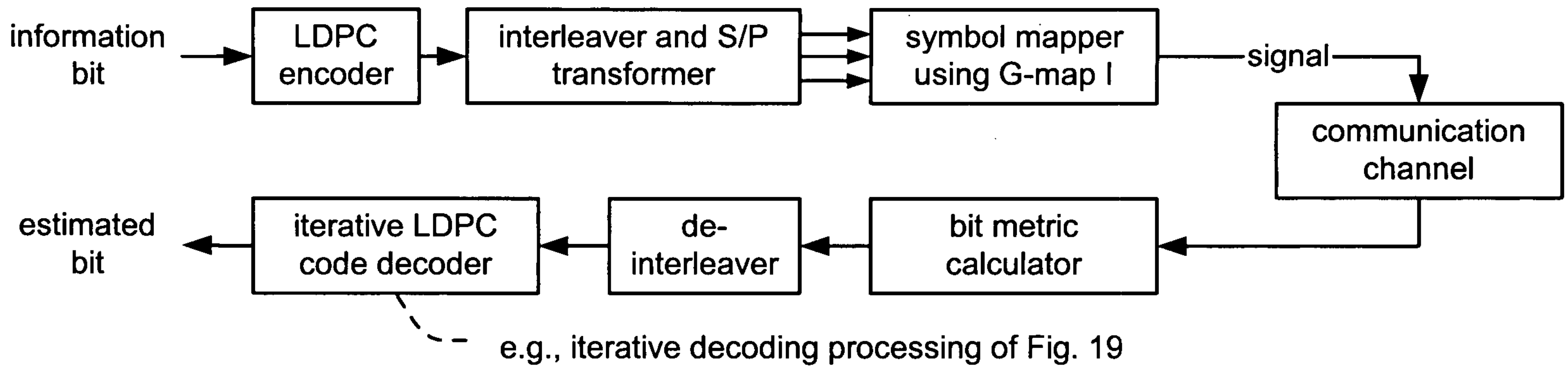
interleaver and S/P (Serial to Parallel) transformer as performed within an LDPC-BICM system

Fig. 37A



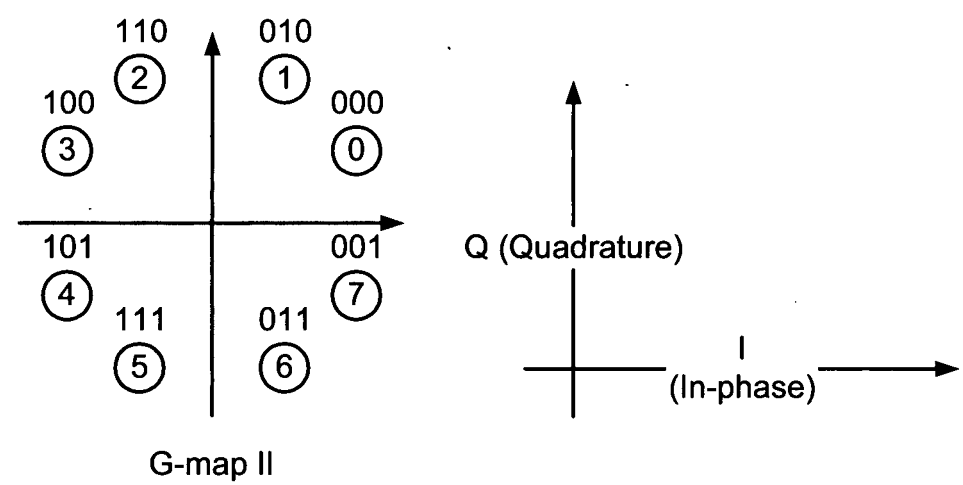
G-map I (Gray code map) (shown using 8 PSK shaped constellation)

Fig. 37B



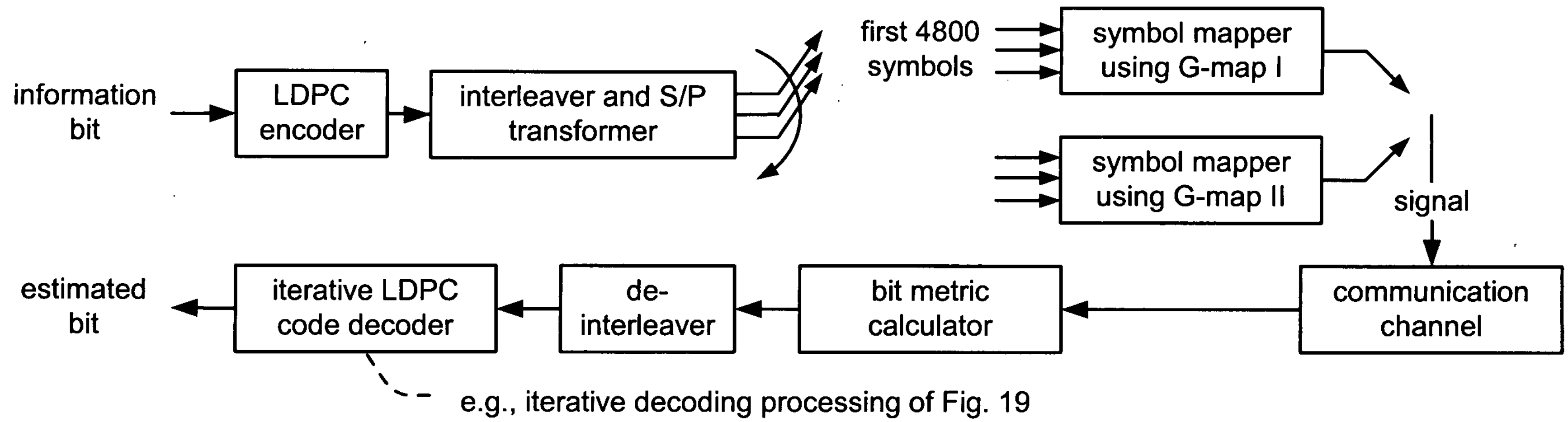
LDPC-BICM communication system I (encoding using single Gray code map and decoding using bit metric only)

Fig. 38A



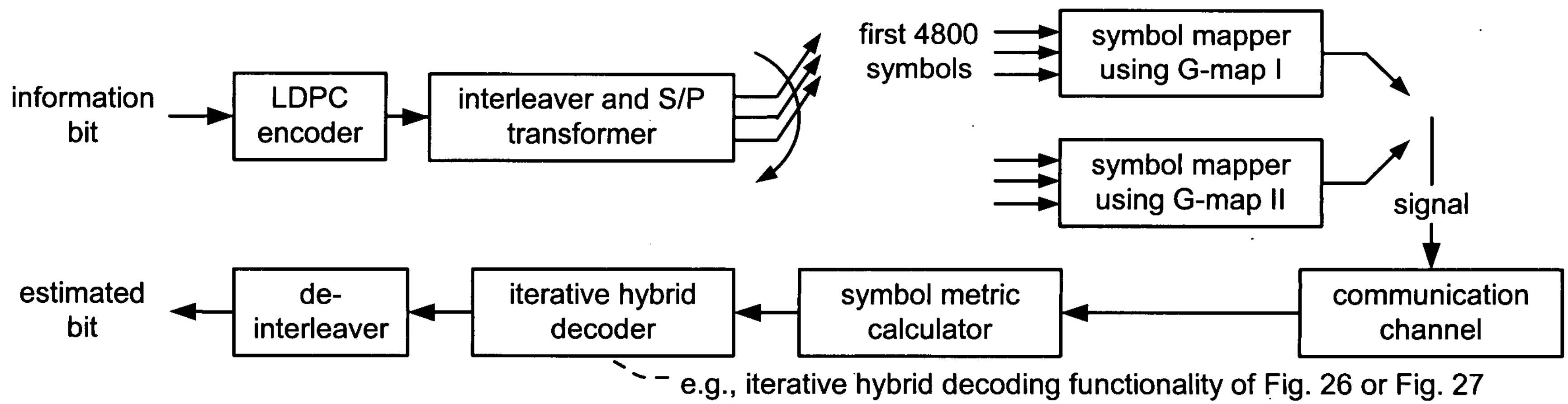
G-map II (Gray code map) (shown using 8 PSK shaped constellation)

Fig. 38B



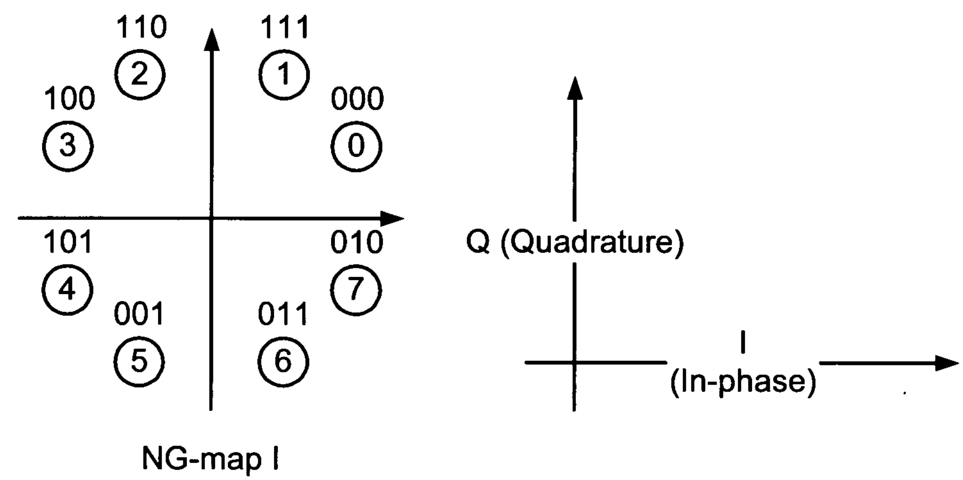
LDPC-BICM communication system II (encoding using 2 Gray code maps and decoding using bit metric only)

Fig. 39A



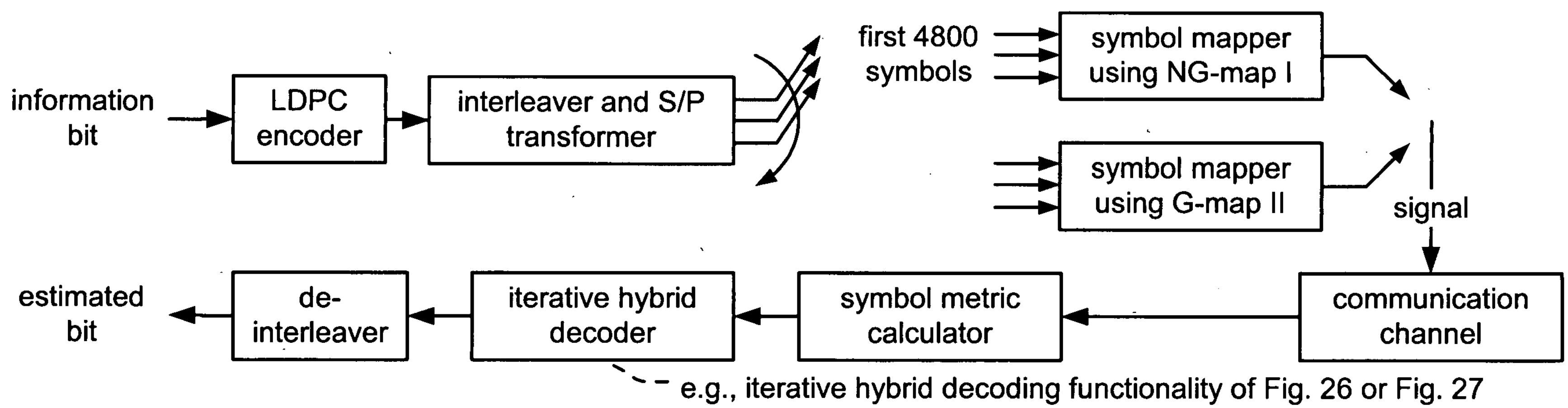
LDPC-BICM communication system III (encoding using 2 Gray code maps and decoding using hybrid decoding approach)

Fig. 39B



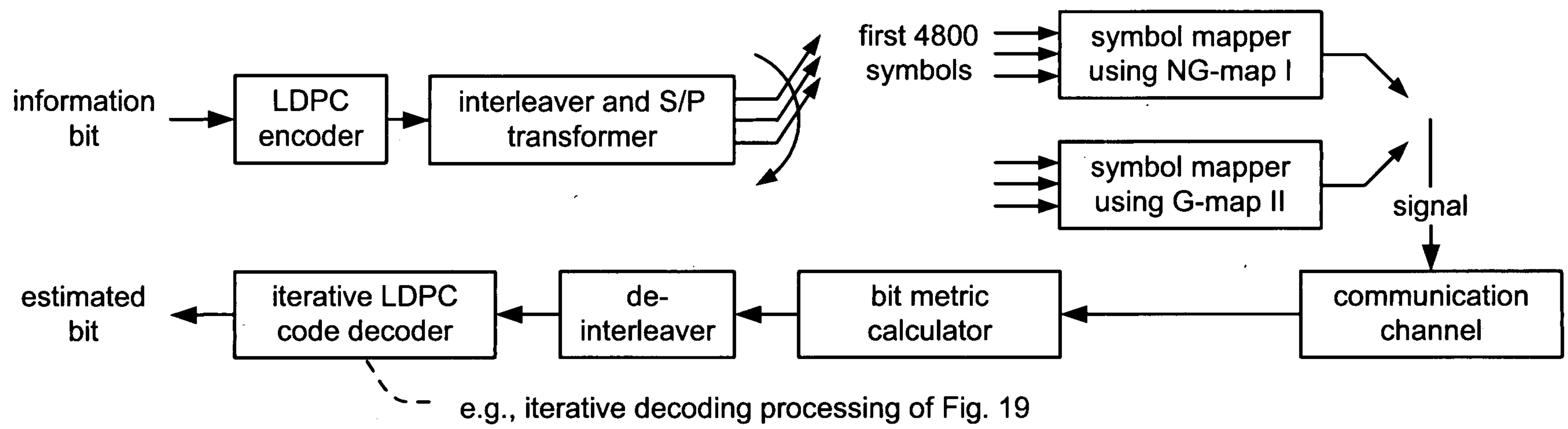
NG-map I (non-Gray code map) (shown using 8 PSK shaped constellation)

Fig. 40A



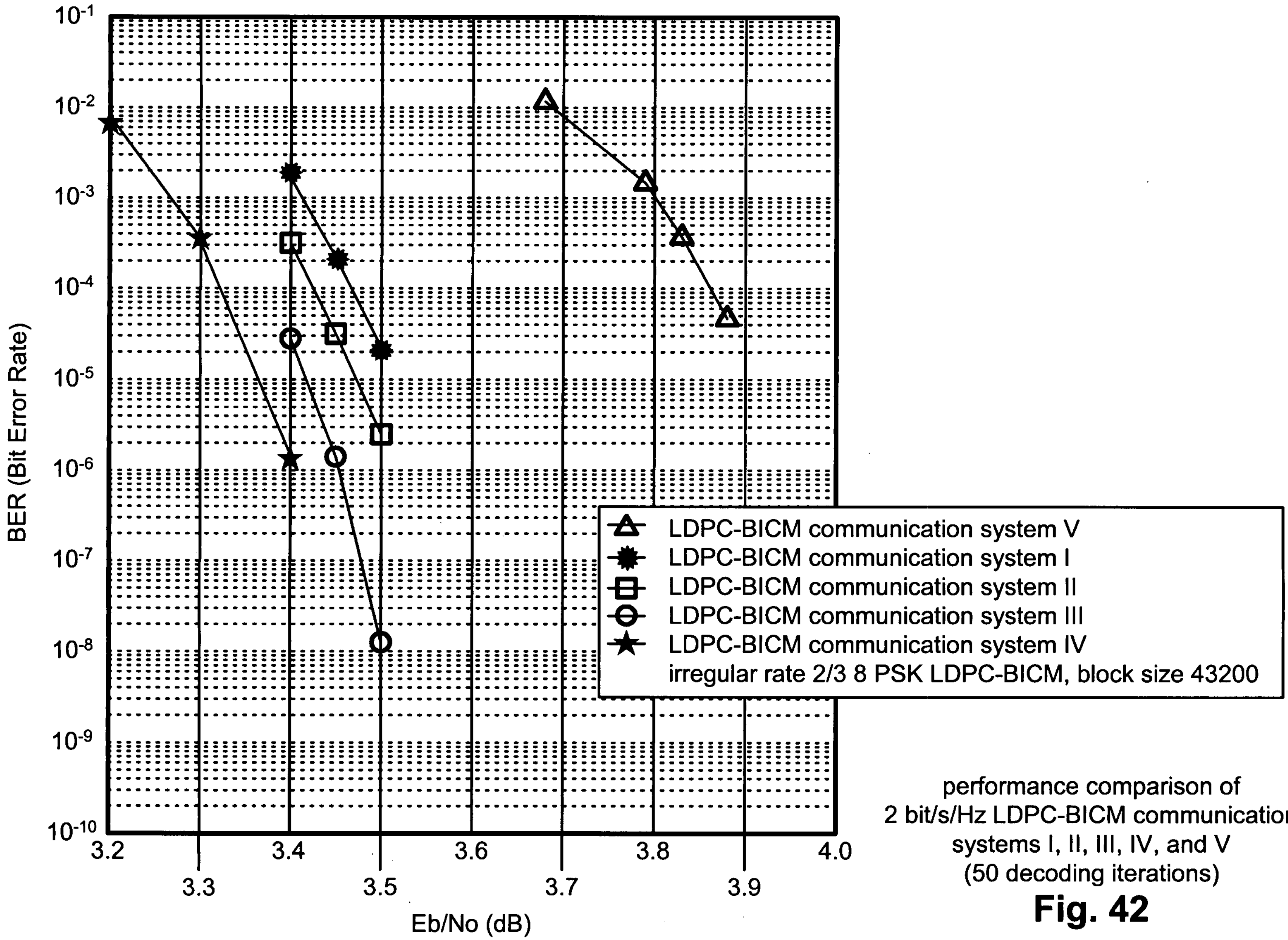
LDPC-BICM communication system IV using NG-map I (encoding using 1 Gray code map, 1 non-Gray code map and decoding using hybrid decoding approach)

Fig. 40B



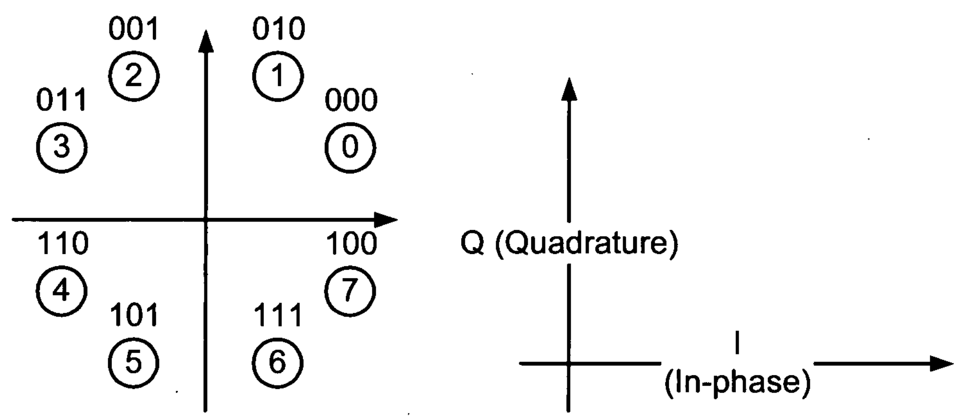
LDPC-BICM communication system V (encoding using 1 Gray code map, 1 non-Gray code map and decoding using bit metric only)

Fig. 41



performance comparison of
2 bit/s/Hz LDPC-BICM communication
systems I, II, III, IV, and V
(50 decoding iterations)

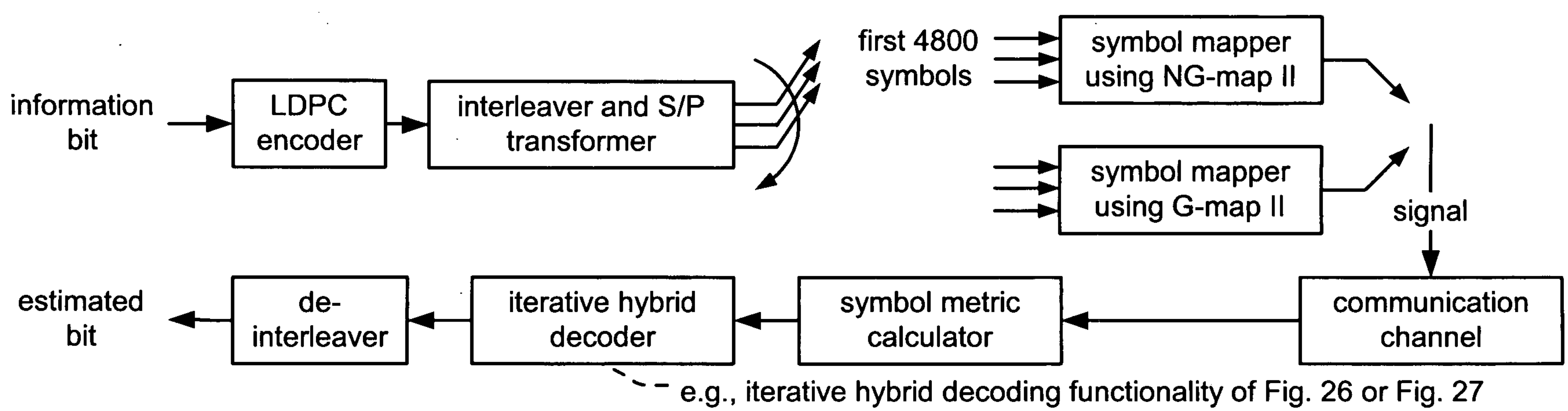
Fig. 42



NG-map II

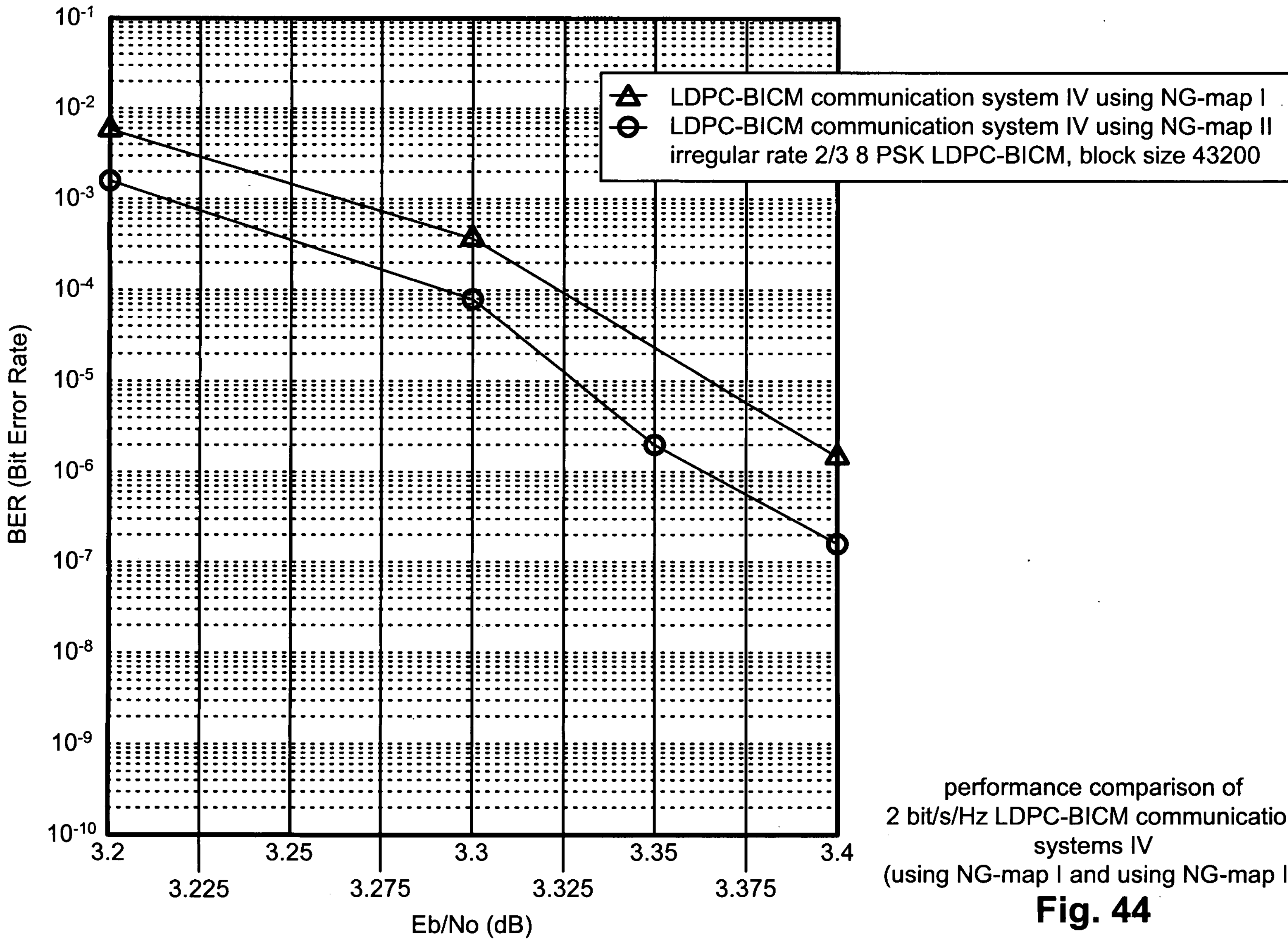
NG-map II (non-Gray code map) (shown using 8 PSK shaped constellation)

Fig. 43A



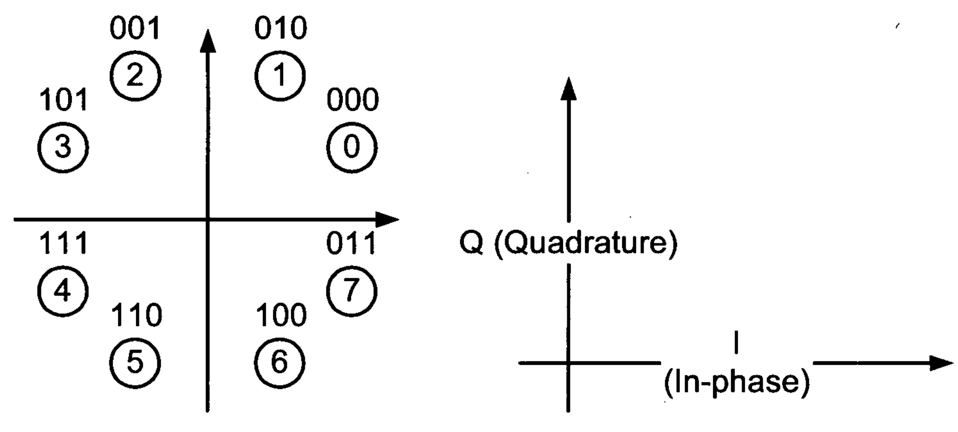
LDPC-BICM communication system IV using NG-map II (encoding using 1 Gray code map, 1 non-Gray code map and decoding using hybrid decoding approach)

Fig. 43B



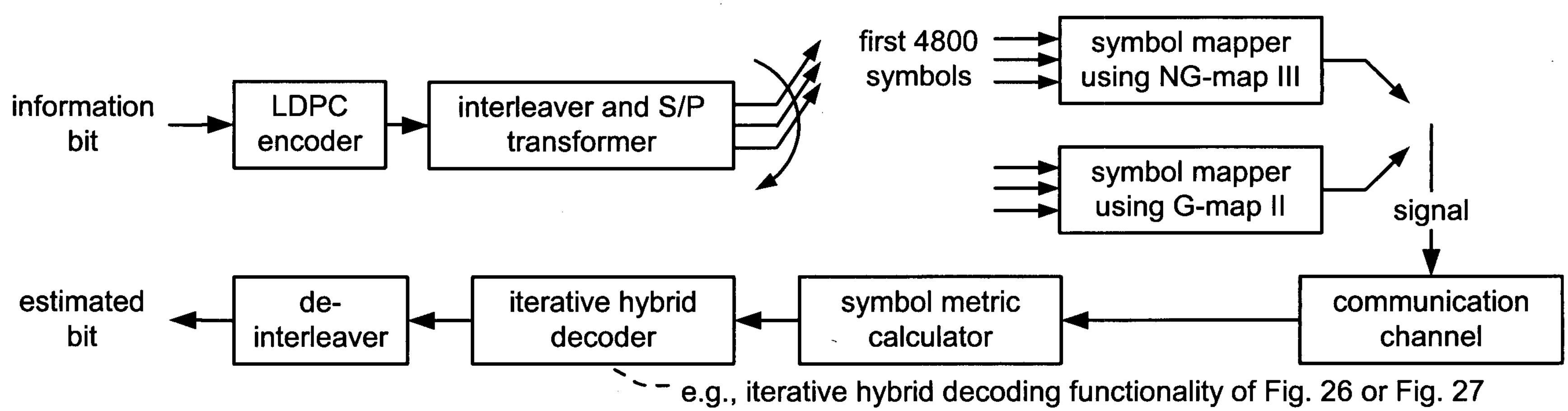
performance comparison of
2 bit/s/Hz LDPC-BICM communication
systems IV
(using NG-map I and using NG-map II)

Fig. 44



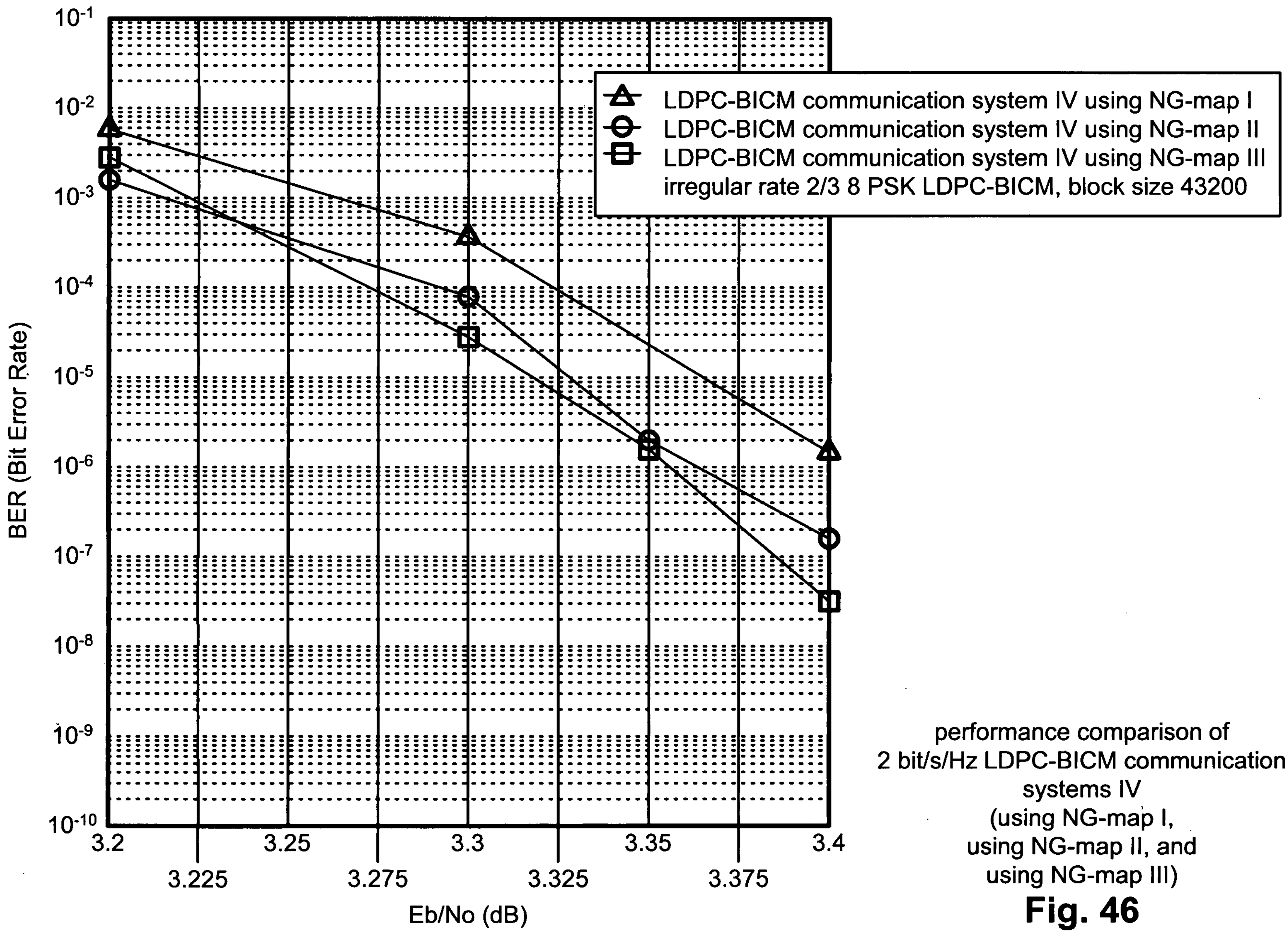
NG-map III (non-Gray code map) (shown using 8 PSK shaped constellation)

Fig. 45A



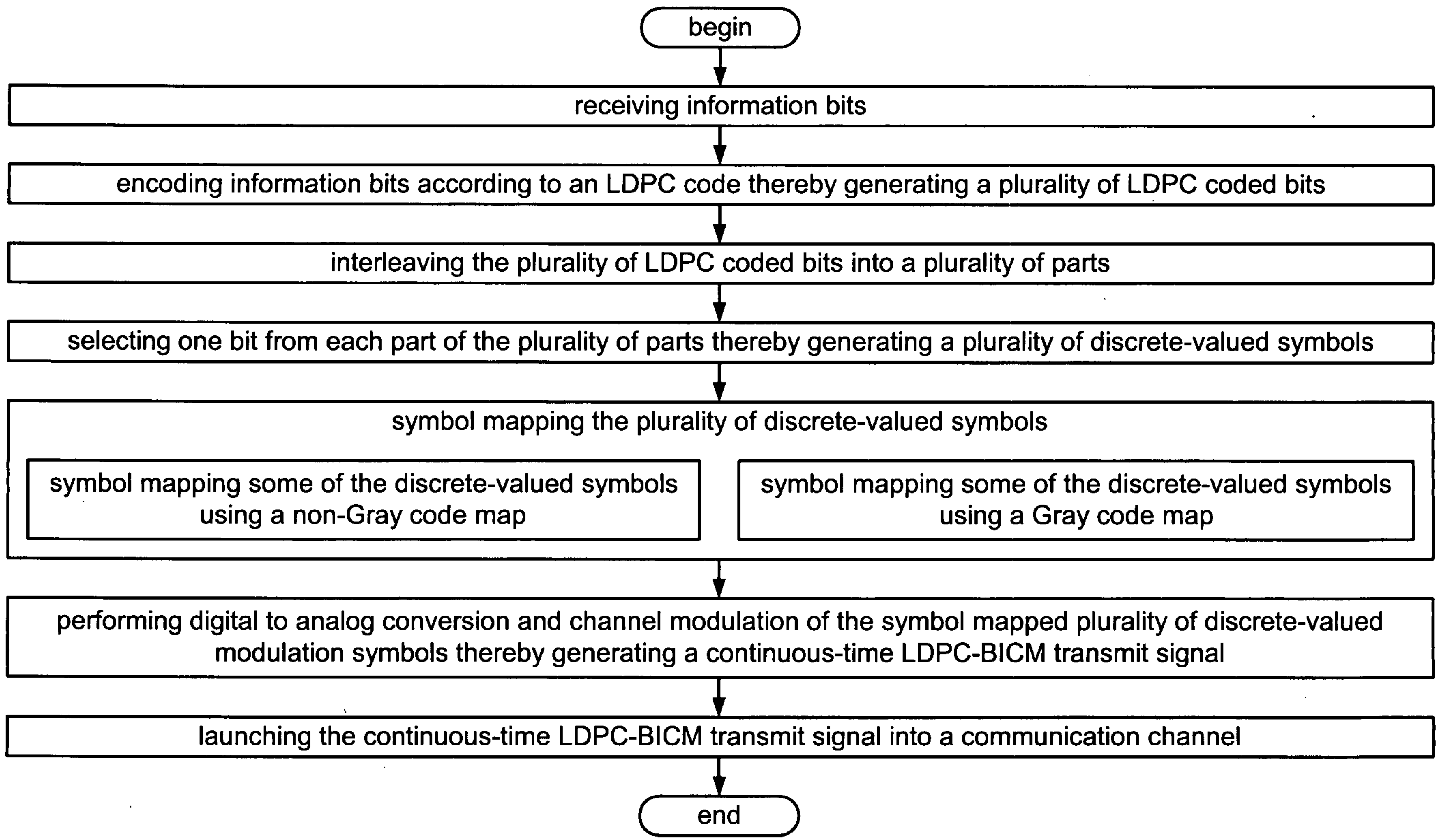
LDPC-BICM communication system IV using NG-map II (encoding using 1 Gray code map, 1 non-Gray code map and decoding using hybrid decoding approach)

Fig. 45B



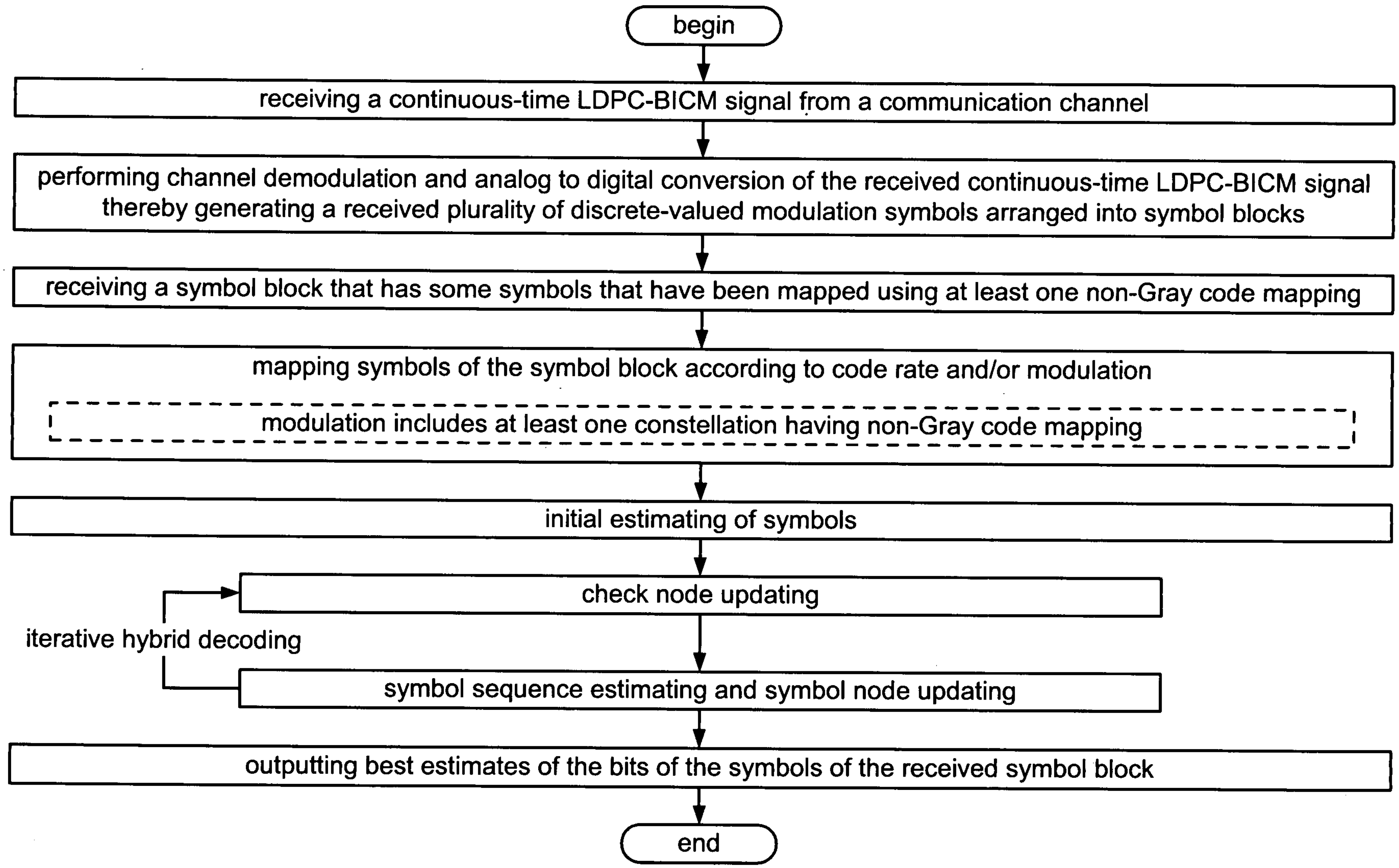
performance comparison of
2 bit/s/Hz LDPC-BICM communication
systems IV
(using NG-map I,
using NG-map II, and
using NG-map III)

Fig. 46



method for generating an LDPC-BICM signal having a non-Gray code mapping

Fig. 47



method for hybrid decoding of LDPC-BICM signal having a non-Gray code mapping

Fig. 48